



Hope FOR THE Homeless

BY JEFF BECKSFORT, P.E., MEMBER ASHRAE

A cornerstone of Portland, Ore.'s strategy to end homelessness in 10 years is Bud Clark Commons. This mixed-use project composed of a day center and housing brings people of need and a range of services designed to treat the causes of homelessness, not just the symptoms, into the same building. The design team approached the project with the attitude that addressing basic needs is not exclusive of design that dignifies the human condition, resulting in spaces filled with daylight, fresh air and views of nature. The facility uses half the energy of a comparable building, and savings from the efficient features are reinvested into programs and services.

Commissioned by the public agency Home Forward (formerly Housing Authority of Portland), the new LEED Platinum certified building provides residents access to services via a walk-in day center; transitional and temporary beds; and efficient studio apartments for 130 women and men. Rent and utilities are subsidized based on resident income.

The Center uses a range of highly efficient systems, including graywater reclamation and one of the largest solar hot water heating systems in the Northwest. The eight-story building is 51% more energy efficient than a similar building as defined by ENERGY STAR Target Finder median building performance. The Target Finder uses a database of actual energy consumption of existing buildings to provide a benchmark that new buildings may use as a comparison for predicted energy use. The building is also 55% more water efficient than required by the 2007 Oregon Plumbing Specialty Code.

Sustainable Design

Sustainability at Bud Clark Commons meant creating a durable place of dignity for the homeless population while treading lightly on the planet. The benefits to building users' health were considered in each design decision.

Locally sourced materials were chosen for their durability, and low-VOC paints, stains and sealants are used throughout. Natural light infiltrates interior spaces, while efficient LED and fluorescent fixtures reduce energy use when artificial light is needed.

A green roof on part of the building filters rain and reduces storm



Above The day center offers holistic services for the homeless to aid in obtaining and maintaining housing. Services include access to showers, mail and computers, wellness and counseling spaces, pet kennels, a barbershop and even occasional access to lawyers and judges.

Opposite The Bud Clark Commons is an elegant mix of design, public function and sustainability. The high performance envelope optimizes daylight into the building while minimizing heating/cooling energy.

water runoff, and bioswales control storm water. The green roof also provides an appealing view from the building balconies at each floor. Energy-saving technologies, materials and construction methods were used to ensure public resources are used wisely. Energy- and water-saving features include demand-control ventilation; a solar hot water system, which heats 80% of the building's hot water; and a graywater recycling system.

Envelope. Eliminating heating energy was a high priority in minimizing building energy use in

BUILDING AT A GLANCE

Name	Bud Clark Commons
Location	Portland, Ore.
Owner	Home Forward (formerly Housing Authority of Portland)
Principal Use	Mixed-use (includes affordable housing, day use center, homeless shelter, administrative office, social services)
Occupants	130 single-occupant apartments, 90 bed men's shelter, 20 office employees
Occupancy	100%
Gross Square Footage	108,000
Conditioned Space	105,000
Total Cost	\$28 million
Cost per Square Foot	\$260
Substantial Completion/Occupancy	June 2011
Distinctions/Awards	LEED NC v2.2 Platinum, 2011; AIA/COTE Top Ten Green Projects, 2014; American Council of Engineering Companies (ACEC) Project of the Year, 2012; AIA/HUD Secretary's Award, 2012; American Society of Landscape Architects Professional Awards, Residential Design Category, Honor Award, 2013



Top A community garden (right) tucked into a covered patio provides a space for residents to enjoy the outdoors.

Above Rainwater from roofs is directed to courtyard bioswales, which provide rainwater detention on site. Native landscaping, non-invasive species, and no permanent irrigation result in zero storm water runoff.

Portland's heating-dominant climate (4,214 heating degree days). A typical building in the Pacific Northwest uses approximately 45% of its annual energy for heating; at Bud Clark Commons, heating accounts for approximately 40% of the total annual energy use.

The efficient envelope includes 3 in. of continuous rigid exterior insulation, fiberglass windows and

tightly sealed details to prevent air leakage. This efficient skin results in a low balance point temperature that eliminates the need for space heating unless outside temperatures are below approximately 20°F.

The design team worked closely with the general contractor to analyze various building skin options to optimize insulation levels and window performance. This envelope optimization required an initial additional cost of \$30,000 and has resulted in annual energy cost savings of \$5,000 (a six-year simple payback) compared to current code required construction.

HVAC. Due to the multiple occupancies and uses of the building, multiple HVAC systems were designed to provide optimal performance for each area.

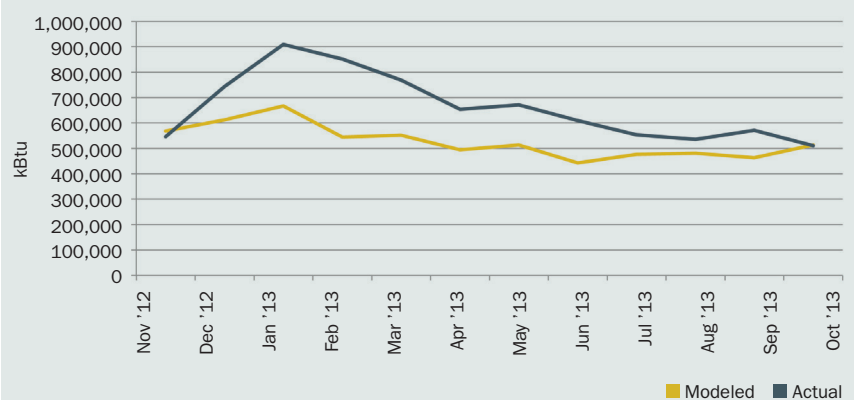
The residential units are served by a dedicated outdoor air system with heat recovery and direct supply ducted to each apartment to provide improved indoor air quality. Providing the distributed outdoor air supply to each apartment with heat recovery from the exhaust

KEY SUSTAINABLE FEATURES
Solar hot water.
Heat recovery ventilators.
High performance exterior envelope.
LED fixtures (used for building façades and exterior areas).
Daylight harvesting.
Interior windows located high on the wall of residential unit bathrooms allow light to penetrate further into the space and provide some natural daylighting.
Fiberglass windows.
Green roofs.
Bioswales.
Graywater recycling.
Low-VOC paints, stains and sealants.
Low-flow, water-saving plumbing fixtures to reduce costs.
Locally-sourced materials.

air increased the cost for this system by approximately \$94,000, but resulted in a \$26,500 annual energy cost reduction (or a 3.5 year simple payback).

Heating in the residential units is provided by tempered ventilation air and electric cove heaters. Operable

FIGURE 1 MODELED VS. ACTUAL ENERGY USE, 2012-2013



windows also provide individual control while window sensors prevent heating while the window is open.

The rest of the building is divided between six variable air volume rooftop air-handling units with direct expansion cooling and hydronic heat. Heating water is provided by two high-efficiency condensing boilers and variable speed pumps. When compared to traditional gas furnace heat this system saves \$14,000 annually, but the additional cost is approximately \$224,000 (for a simple payback of 16 years).

Many of the building's residents have compromised immune systems and/or respiratory illness due to poor living conditions. Creating an indoor environment that not only eliminates the spread of disease, but also creates a healthy indoor environment was crucial.

Dedicated HVAC systems serve areas most susceptible to the spread



Bud Clark Commons features 130 single-occupant apartments. Each unit is provided with direct ducted outdoor fresh air through rooftop heat recovery systems. Interior windows located high on the wall of the bathrooms allow daylight to penetrate further into the space and provide some natural lighting.

of tuberculosis and other airborne diseases, such as the men's shelter and the day-use facility. Each air-handling unit includes MERV 13 filtration; this level of filtration is well beyond the code minimum requirements and is capable of filtering out bacteria, pollen and mold.

The building's HVAC system provides tuberculosis control with displacement ventilation, UV filtration, and double the typical air change rate for shelter sleeping rooms. To further improve indoor air quality, the hygienic facilities in the day center, which includes shower and laundry rooms, were designed with a dedicated exhaust system to provide a minimum 2 cfm/ft² exhaust.

The high exchange rate of airflow in these spaces prevents air quality issues associated with high humidity environments such as mold growth and water damage. Heat recovery is also provided at the exhaust airstream to recover heat from exhaust air, minimizing energy use associated with higher makeup air rates.

Water Systems. Using low flow faucets, showerheads, water closets and urinals reduces domestic water use. The building's graywater reclamation system provides additional water savings by collecting water from bathtubs, showers, clothes washers and laundry tubs in the day center for later reuse. The system is comprised of an initial holding tank, ejector pumps, multiple-stage filtration and a graywater storage tank. A booster pump system distributes the graywater from the storage tank to the water-efficient toilets and urinals throughout the building for flushing.

“Designing for people experiencing homelessness required a deft understanding of how to create warm and inviting design solutions that also stood up to high levels of use and sometimes abuse. ... We liken the project to trying to combine the welcoming environment of one's home with the durability of a penitentiary.”

Source: AIA/COTE Top Ten Green Projects narrative

ENERGY AT A GLANCE

Annual Energy Use Intensity (EUI) (Site)
75.5 kBtu/ft²

Natural Gas 30.8 kBtu/ft²

Electricity (From Grid) 44.7 kBtu/ft²

Annual Source Energy 181 kBtu/ft²

Annual Energy Cost Index (ECI) \$1.61/ft²

Savings vs. ENERGY STAR Target Finder
51%

Heating Degree Days (base 65°F) 4,214

Cooling Degree Days (base 65°F) 433

Average Operating Hours per Week
168 (8,760 per year)

WATER AT A GLANCE

Actual Annual Water Use 7 million gallons

Annual Water Savings 55%



TRANSITIONING TO STABILITY

In Portland, an estimated 3,024 people sleep on the streets each night. However, this is not just an issue in Portland. The approximately 210,000 shelter beds currently available in the United States can only serve 21% of the homeless population.

The Bud Clark Commons provided aid, shelter and permanent housing to more than 5,000 people during its first two years of operation. The project's sustainable features reduce its effects on the environment, and provide benefits for occupants such as improved indoor air quality and daylighting. The building's graywater reclamation and solar hot water systems alone are saving the owner nearly \$33,000 annually and translate into additional funds for services.

The building's day center resources include a variety of holistic services aimed at assisting people to gain and maintain permanent housing. Basic hygiene, access to mail and computers, wellness and counseling spaces, pet kennels, a barbershop and even occasional access to lawyers and judges are among the services provided in the center.

The transitional men's shelter provides housing, safety and resources to aid in the transition between homelessness and a more stable lifestyle. The shelter features temporary housing for 90 men for three months, dining facilities, an exercise room and private courtyard, laundry center and counseling offices. Finally, 130 units of permanent housing are offered at an affordable rate, and are coupled with Bud Clark Commons' comprehensive services to the most vulnerable of homeless individuals as determined by a rating system.

Developed in accordance with state and local jurisdictions, this system required careful attention to filtration, storage and disinfection to ensure the safety and health of the occupants and building operations staff. Among these safety measures is an automated chlorination system for disinfection and sterilization and multiple filter stages.

The system reduces potable water use by 55% and results in approximately \$24,000 in water cost savings and 600,000 gallons of water per year (compared to a similar building meeting the 2007 Oregon Plumbing Specialty Code). The graywater system effectively eliminates the use of drinking water

Top left A sunken garden provides a private area of outdoor refuge for the residents of the 90-bed men's shelter. The garden includes a water feature that also serves to provide rainwater detention.

Below Efficient lighting design and daylighting are key sustainable features used throughout the building. The multipurpose room provides space for a variety of community events.



BUILDING ENVELOPE

Roof

Roof Type Insulation above concrete deck
Overall R-value R-40 continuous insulation

Walls

Type Metal stud with 3 in. continuous exterior insulation
Overall R-value R-26
Glazing Percentage 25%

Windows

Effective U-factor for Assembly 0.33
Solar Heat Gain Coefficient (SHGC) 0.31
Visual Transmittance 0.5

Location

Latitude 45.5° north
Orientation North/south

for flushing toilets and urinals in the building.

Due to the consistently high demand for domestic hot water, a solar hot water system was determined to be more cost-effective than a solar PV system. A 116-panel, rooftop solar hot water system produces a majority of the hot water used in the building. The drainback



Top A fitness room is provided for residents of the temporary men's shelter. A commercial kitchen run by volunteers provides daily meals to the residents.

Above A graywater reclamation system recovers water from showers and laundry machines in the day center for reuse in flushing toilets. The system is saving approximately \$2,000 per month in reduced water use costs.

type solar hot water system results in approximately \$9,000 in energy cost savings per year, and a significant reduction in the use of fossil fuel-based utilities.

Flat-plate type solar collection panels collect heat from the sun's radiation, and a pump circulates water between the panels, heating the water that is held in a 5,000 gallon storage tank. The system was designed to meet the building's entire hot water needs on a typical sunny, summer day.

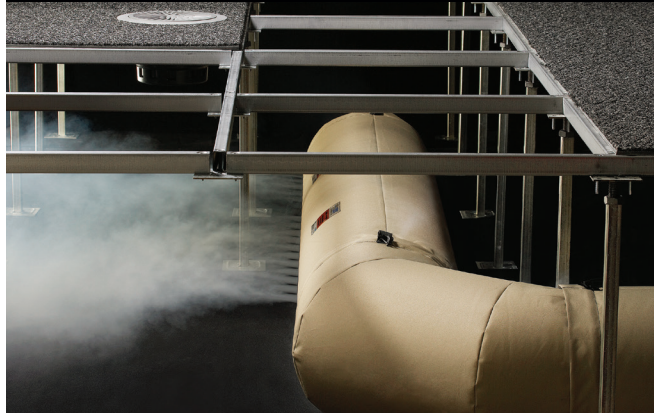
After federal and state incentives, the payback period for the solar hot water system was determined to be 15 years. An analysis determined that the solar hot water system would offset more carbon generation annually than a solar PV system.

Cost-Benefit Analysis

Funded with limited public monies, a cost-benefit analysis was performed to support decision making throughout the design process. Because Home Forward plans to own and occupy the Bud Clark Commons building for years to come, the project team evaluated several energy conservation measures by life-cycle cost.

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This courtyard provides an outdoor area out of the public right-of-way where people can wait to use the day center.

Energy and water conservation measures with longer simple paybacks than are typically accepted by building owners were implemented to provide reduced operations costs. The estimated simple payback for the incorporated energy and water conservation measures is 14 years. With long-term occupancy, additional savings are anticipated as energy

BUILDING TEAM

Building Owner Home Forward
(formerly Housing Authority of Portland)

Architect Holst Architecture

General Contractor Walsh Construction

Mechanical, Electrical Engineer, and Lighting, Low Voltage and Energy Modeler PAE

Structural Engineer
ABHT Structural Engineers

Civil Engineer KPFF Consulting Engineers

Sustainable Design, LEED Documentation and Commissioning Green Building Services (GBS)

Interior Design Czopek & Erdenberger
Interior Design (C&E)

Environmental Graphics, Landscape Architecture Mayer/Reed

Cost Estimating Architectural Cost Consultants (ACC)

and water rates continue to increase. Anticipated annual operations cost savings were shifted to fund the sustainable design elements.

Measurement and Verification

Data collection through a network of submeters allows for measurement and verification of the building's core HVAC, lighting and miscellaneous plug load systems. The building management system enables Home Forward to monitor the performance of the building, which is actually using approximately 30% more energy than predicted with energy modeling.

The building occupancy was initially modeled to reflect typical office hours for much of the space as well as residence hall-type occupancy for the day-use facilities and men's shelter for an anticipated energy use intensity (EUI) of 58 kBtu/ft²·yr. The actual EUI for the building for its second year of operation is 75.5 kBtu/ft²·yr.

This higher energy use is because the day-use and men's shelter portions of the building operates more similarly to the higher energy intensive use of a hotel. Also, the office areas of the building have operating hours close to 24 hours a day, seven days a week. And, the day-use

facilities and men's shelter commercial kitchen sees extensive use, serving multiple meals daily.

This increase in use and occupancy resulted in higher energy use than anticipated for lighting and ventilation. The ENERGY STAR Target Finder median building performance 154 kBtu/ft²·yr based on similar building occupancies. While higher than anticipated, the actual building energy use is still 51% lower than this baseline.

In addition to tracking the core systems, a sampling of individual residential units have submeters installed

HEALTH-CARE COSTS DECREASE FOR BUD CLARK COMMONS RESIDENTS

Bud Clark Commons aims to be a holistic source for the homeless community, with the goal of providing the resources needed for a more stable, less vulnerable life. A recent study shows that residents had decreased health-care costs and residents reported fewer unmet medical needs after moving into one of the facility's 130 studio apartments.

Health-care costs for the 59 Medicaid recipients tracked in the study dropped by 55% during the year following their move into Bud Clark Commons compared to the previous year. Those savings, however, were inflated by 9% because two residents apparently died soon after moving in.

One of the researchers who directed the study cautioned that the study only shows an association of reduced health-care costs with moving into the Commons, not a cause-and-effect relationship.

Residents also reported an improvement in their quality of life, with 79% of 98 respondents reporting unmet physical health needs and 45% reporting unmet mental health needs during the year preceding move-in. In the year after, those percentages dropped to 48% and 17%, respectively.

Source: The Oregonian, April 10, 2014
(<http://tinyurl.com/mfh14jw>)

Innovative Flow and Energy Measurement



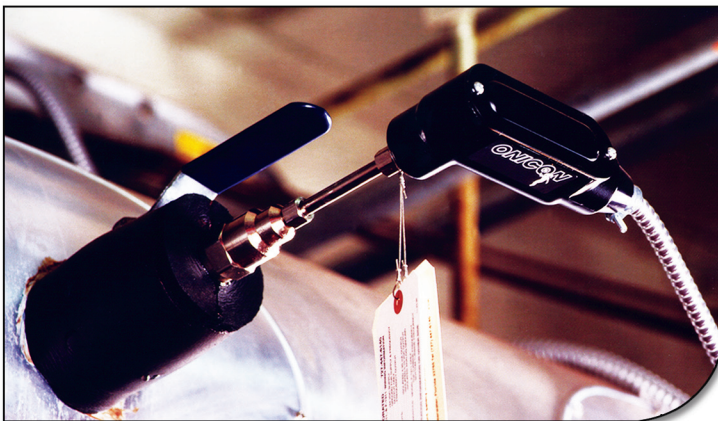
Common Applications

- Energy Management
- Cost Allocation
- Flow Control
- Tenant Billing
- LEED Certification
- Major Equipment Efficiency
- Energy Plant Efficiency



Common Systems

- Chilled Water
- Hot Water
- Domestic Water
- Natural Gas
- Steam Systems



Flow Meters and BTU Meters

- Insertion and Inline Turbine and Electromagnetic
- Vortex Steam
- Thermal Mass
- Clamp-on Ultrasonic
- BTU Meters



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LESSONS LEARNED

Engage Key Decision Makers When Setting Project Goals. Early design charrettes allowed all stakeholders to provide input into the design and approach for the building. Engaging the decision makers provided an opportunity to prioritize goals for the project and separate the needs from the wants. In addition, this collaboration allowed engagement between the parties responsible for the capital budget and the operations budget when establishing trade-offs between first cost of energy-efficiency measures and life-cycle costs.

Graywater System Design. While rainwater reclamation is a widely accepted and proven strategy to reduce potable water use, graywater recovery systems are sometimes overlooked as an option. Rainwater was initially evaluated for the project, but was determined to not be as cost-effective as a graywater reclamation system.

In Portland, sufficient rainwater is available for collection typically between October and June, while the summer months are quite dry. The demand for water for flushing for this building is consistent year-round. One function of the building program is serving the homeless community by providing shower and laundry facilities that are available and used approximately 14 hours per day. This results in a substantial source of water that may be reused for flushing toilets.

One design challenge realized after installation of the system is the amount of lint and debris from the laundry and showers. The addition of backwashing filters and point of use filters were required to minimize the collection of debris into the graywater collection system. The graywater system is saving approximately \$2,000 per month in reduced water use costs.

Designing to Avoid Transmission of Tuberculosis in Shelters. While designing for high levels of indoor air quality was a primary requirement for the project, it was determined during early collaboration that the spread of tuberculosis is a big concern for the transitional population. While the Center for Disease Control and Prevention (CDC) outlines recommendations for preventing the spread of this disease, including prescreening, the HVAC system was identified as a large component to prevention as the disease is spread through the air. This building is the first homeless shelter in Portland to incorporate the HVAC distribution system into the prevention of tuberculosis, and no new cases of this disease have been reported.

Reducing Building Footprint. Due to budget constraints, the decision was made to reduce the footprint of the building, build a taller building and “land bank” the adjacent site. This allowed the land owner to develop the adjacent site into an integrated social services solution. The adjacent development is planned to be a medical facility combining various services that serve a similar population to those using Bud Clark Commons. As a result of the potential revenue from the adjacent site, the building team was able to secure the funding necessary for Bud Clark Commons.

Indoor Air Quality/Heat Recovery. The traditional strategy for ventilation of affordable housing facilities is to supply air into corridors and exhaust air through apartment bathrooms. This leads to poor indoor air quality in the apartments and high heating energy costs, and is an issue in other affordable housing properties in Portland.

Direct ventilation air into each apartment ensures that they receive the air exchanges needed to prevent the buildup of pollutants that cause poor indoor air quality. Centralized heat recovery systems recover the heat exhausted from bathrooms by manifolded the exhaust ducts from each bathroom at rooftop air-handling units, recovering the heat to be exhausted, transferring the heat to the ventilation air, and distributing this air to the building. This heat recovery reduces the energy required to heat the ventilation air. Providing the distributed supply to each apartment with heat recovery increased the cost for this system by approximately \$94,000, but resulted in a reduction of \$26,500 in annual energy cost (or a 3.5 year simple payback).

Electric Heat. Balance point calculations and optimization of the thermal envelope performance result in limited space heating required in each of the apartments. While electric heat is generally not favored due to its high energy costs, it is a cost-effective solution if heating is reduced to only provide slight temperature adjustments according to the preferences of each occupant as opposed to being the primary heat source for the space. Ventilation air is tempered to provide the heating necessary to keep the indoor air temperatures comfortable for most occupants.

Window sensors and programmable thermostats in the apartments prevent the use of the electric heaters while the windows are open. The electric utility bills for each apartment average approximately \$30 per month, and closely match the anticipated utility costs for electricity.

to track consumption on a circuit-by-circuit basis. A further study is planned to evaluate the energy end uses of the residents once two years of data have been collected.

Initial indications are that the actual energy use for the residential units matches the projected use. The metering is intended to help the owner identify systems operations and resident behavior issues in the building that result in wasted energy. Residents and visitors are educated about the building’s multiple sustainable measures through the move-in orientation process, ongoing life-skill training, signage and building tours.

Conclusion

The design team worked closely together in an integrated design and construction process to deliver a beautiful, highly functional and energy- and water-efficient facility. The project was completed within the owner’s time frame and budget constraints, and the measurement and verification systems are allowing continued monitoring of building performance.

The resulting energy and water cost savings are directly reallocated to services for the building’s occupants. In fact, annual savings from energy and water savings are sufficient to provide 32,850 meals a year, or dinner for all 90 men in the shelter seven days a week for all 52 weeks in the year. ●

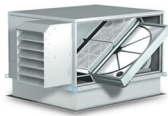
ABOUT THE AUTHOR

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Energy Recovery



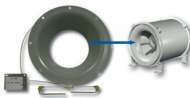
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