MULTIFAMILY AFFORDABLE HOUSING THAT IS HEALTHY, EFFICIENT, COST EFFECTIVE AND LEED PLATINUM

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INTRODUCTION

A developer who had chronic asthma as a child built the first LEED® (Leadership in Energy and Environmental Design) Platinum certified apartment complex in Idaho. He has also heard from two residents that their asthma no longer resulted in attacks due to eliminating triggers in the interior environment. Eight years and a dozen multifamily affordable housing projects later, the LEED consultant on these projects has gathered insight on best practices, lessons learned and strategies that result in resident, owner and project team satisfaction. Ten projects have achieved LEED Platinum certification (two more are still under construction, but are on track for Platinum), and the HERS (Home Energy Rating System) scores are as low as 48. Feedback has been collected on what works, what doesn't and what matters most: from low energy bills to living in a healthy home and not having asthma attacks. These projects debunk the assumptions that energy efficiency adds too much cost or that green homes are only for the wealthy.

KEYWORDS

LEED, healthy homes, energy efficient, cost effective, asthma, affordable housing, green building, integrated design, design charrette, high performance

COMMON THEMES

All twelve of these projects are located in Idaho, and were recipients of tax credit financing through the Idaho Housing and Finance Association (IHFA). Each year, IHFA issues a Qualified Allocation Plan (QAP) that defines guidelines for applying for tax credits. Green and energy efficient measures as well as LEED certification were introduced into the QAP by the aforementioned developer who had asthma as a child. This has been significant for affordable housing in Idaho. Most developers are choosing green and energy efficient measures to add points to their application, and a dozen projects are now certified at or pursuing the highest level of LEED.

Most of these projects are 3-story, 48-unit buildings, and are located in climate zones five and six and in moderate to high radon risk areas. Some were designed for seniors, and some for families. There are some consistent themes between the LEED credits pursued. For example, most projects have high density in infill locations and are near 10 to 15 community

1. Eco Edge. PO Box 6205, Ketchum, ID 83340, www.buildingecoedge.com.

resources within a half-mile. Owners see the long-term value in durability management and water-efficient landscaping, irrigation and plumbing fixtures. The benchmark for turf has been to install 100% drought-tolerant turf and ensure that conventional turf makes up less than 20% of the designed softscape, with some teams opting for 0% and avoiding maintenance-intensive turf altogether. Most teams have chosen to install over 90% drought-tolerant plants, which is in line with much of Idaho being a very dry climate. (Boise, for example, only receives 10-12 inches of rain per year on average.)

They are paying attention to framing efficiencies, recycled products (such as doors, trim and insulation) and local materials (such as concrete and timber). Construction waste is responsibly managed even though Idaho tends to have fewer recycling opportunities than other areas of the country. For example, gypsum cannot be recycled. Regardless, every project has been able to divert at least 50% of their construction waste.

Healthy interiors always come up as a goal in the design charrettes, and all projects have benefitted from holding charrettes as a way to invest in integrated design. It is the forum for raising lessons learned from past projects, training new team members and discussing any new technologies or strategies. All teams have pursued good ventilation strategies coupled with low-emission products such as paint, flooring and adhesives and sealants. Every project has a passive radon mitigation system whether required to or not. More recent projects have been certified through Indoor Air Plus, the EPA's voluntary partnership and labeling program that helps new home builders improve the quality of indoor air by requiring construction practices and product specifications that minimize exposure to airborne pollutants and contaminants.

And, most have opted to host enhanced training for residents (a two-hour presentation on the green benefits of their homes and tips on living in it green) and perform public outreach to increase awareness and understanding of LEED and what makes the project healthier and more efficient.

Image courtesy of Glancey Rockwell & Associates

City/State: Boise, ID
Construction Start Date: July 1, 2011
Completion Date: August 1, 2012
Number of Stories: 3
Number of Units: 53
Gross Square Footage: 60,467
Lot Size: 0.78 acres
Density: 67.9 units/acre
HERS Score: 56
Certification: LEED Platinum
Architect: Glancey Rockwell & Associates
General Contractor: Scott Hedrick Construction

LEED® Facts

Mercy Housing Northwest – Idaho
12th and River, Boise, ID

LEED for Homes Program
LEED Platinum Certified

Category	Score
Innovation & Design	10/11
Location & Linkages	10/10
Sustainable Sites	18.5/22
Water Efficiency	9/15
Energy & Atmosphere	21/38
Materials & Resources	15/16
Indoor Environmental Quality	16/21
Awareness & Education	3/3

Total 102.5 Points

Civil Engineer: The Land Group
Electrical Engineer: E2CO
Interior Design: Cornerstone Interior Design
Structural Engineer: McClendon Engineering
Mechanical Engineer: Musgrove Engineering
HVAC Contractor: Hobson Heating and Cooling
Air Sealing/Insulation Contractor: EnergySEAL Air Barrier Systems LLC
LEED Rater: Tad Duby, On Point
LEED AP Homes: Sharon Patterson Grant, Eco Edge

The highest scoring project achieved 102.5 points in the LEED checklist. Mercy Housing Northwest developed the 12th and River project for seniors in downtown Boise. It is an urban infill project with very high density (68 units per acre), which added several points, and great walkability for residents with 14 basic community resources within a half-mile. The development team installed more environmentally preferable products than any other project, and diverted 73% of their construction waste. An example of a product used is the GreenFiber insulation that set a new national standard and UL listing for a 1-hour assembly between floors that results in superior thermal insulation and sound attenuation between units. The worst-case scenario HERS score of 56 was achieved through features such as Mitsubishi Mr. Slim mini-split air-source heat pumps (17.5 SEER and 9.3 HSPF), high-efficiency gas tank water heaters (water for 53 units is heated by three 70-gallon tank gas water heaters that are 94% efficient, with a VRV heat exchanger, which provides approximately 6% of the heating capacity when operating) and windows with a U-value of U-0.27. (LEED requires using the worst of all the units modeled for the official HERS score.)

Sustainable Site and Location

This project scored the maximum number of points available in two LEED categories: Location and Linkages and Awareness and Education. Situating this project on a previously developed site in the urban core of downtown Boise results in benefits to the owners, occupants and community. The owners were able to access existing infrastructure, which reduced upfront costs. Residents have access to over 14 community resources and open public space within less than half a mile walking distance. This translates to a Walk Score® for this location of 88 out of a possible 100 points. A report by Joseph Cortright analyzed data from 94,000 real estate transactions in 15 major markets and found that in 13 of the 15 markets, higher levels of walkability, as measured by Walk Score, were directly linked to higher home values (www.ceosforcities.org/work/walkingthewalk). This site is also in close proximity to the "Pioneer Corridor," which is an effort by the City of Boise and the City's redevelopment agency, Capitol City Development Corporation (CCDC), to redevelop and revitalize a section of downtown. Developing a high-density, quality residence will further diversify and enhance the neighborhood.

Water Efficiency

Although the project team evaluated the feasibility of capturing and storing rainwater, the final water conservation strategies focused on indoor plumbing fixtures and the irrigation system. The average flow rate of lavatory faucets is only 0.5 gpm (gallons per minute), and

showerheads use between 1.1 and 1.5 gpm. Both fixtures are by Moen and meet the WaterSense criteria established by the EPA. The flow rate for toilets is 1.28 gpf. The irrigation system includes a central shutoff valve, timer, moisture sensor and other high-efficiency measures. Most components are by Hunter.

Air Sealing

This project was designed to LEED H standards that require each apartment to be compartmentalized, meaning each unit has to perform individually from the other apartments and common areas with a continuous air barrier for thermal comfort and energy efficiency. Since this project was completed, there has been a national movement towards a new section in the IECC for multifamily buildings, and compartmentalization has been a key aspect of discussion. The building assemblies that make up the thermal envelope include the floors, walls, ceiling, doors and windows. Air sealing each assembly was a priority. A Blower Door test was conducted to calculate air leakage, and units ranged between 2 and 4 ACH50 (air changes per hour at a 50 Pascal pressure differential) compared to the code requirement (2009 IECC at the time of this project) to be below 7 ACH50.

Foundation

The slab-on-grade foundation design is a 4" concrete slab over 4" minimum gravel fill over a vapor barrier that also serves as a capillary break and radon mitigation measure. The slab is insulated with R-15 extruded polystyrene (XPS) insulation, minimum 24" vertically and minimum 48" horizontally. Additionally, R-5 continuous insulation is used as a thermal break between the slab and foundation wall. The passive radon mitigation system consists of a 4" exhaust duct from below slab, routed up in a 6" wall through the 2nd and 3rd floors to the attic. It is terminated through the roof with a roof vent.

Floor Assembly

The floors incorporate the new UL Listing M512 by installing GreenFiber blown-in cellulose insulation into the full depth of the floor joists.

Roof Assembly

The roof is constructed with trusses spaced 24 O.C. (on center) and insulated to R-39 with a combination of spray foam and rigid foam.

Wall Assembly

Advanced framing techniques are utilized throughout this structure. Advanced framing improves energy efficiency by replacing lumber with insulation materials, which improves the whole-wall R-value by reducing thermal bridging and maximizing the wall area that is insulated. The U.S. Department of Energy estimates that fully implementing advanced framing techniques can result in materials cost savings of about $1,000 for a 2,400 sq ft house, labor cost savings of between 3 and 5 percent and annual heating and cooling cost savings of up to 5 percent. Construction cost savings result from the use of less lumber and the generation of less waste. The walls of 12th and River are built with 2x6 lumber at 24" O.C. The cavity insulation is R-21 GreenFiber blown-in cellulose. This is combined with a small amount of spray foam insulation used for air sealing, which increases the R-Value of the insulation to an R-27. The exterior is a solid masonry construction with an air space, Tyvek and weep holes.

Window Assembly

The vinyl-framed windows by Milgard are triple pane, low-emissivity with an exceptional efficiency of U-0.27.

Insulation

GreenFiber cellulose insulation has the health and environmental benefits of being 85% recycled (55% post-consumer and 30% pre-consumer), low-toxicity and locally manufactured with energy-efficient manufacturing and zero waste installation. It does not use chlorine based chemicals that are believed to contribute to global warming. It also provides superior thermal performance and installs to a full R-value by filling around wiring, plumbing, electrical boxes and the space around IC rated recessed lights. This not only provides greater thermal insulation between units, but it also ensures greater sound attenuation, which is highly valued in multifamily buildings.

Prior to the innovative efforts of the project team, this environmentally-superior product with effective thermal performance and sound attenuation was not allowed to be used as floor insulation in a one-hour fire-resistance rated floor because it had not been tested and approved for fire ratings for a one-hour assembly. As a result of the combined efforts of the insulation contractor, City of Boise building officials, Mercy Housing Northwest, LEED Rater, architect, builder and manufacturer, this approach is now approved for projects across the U.S.

The complete listing for UL M512 can be found at http://database.ul.com. Strategies from the listing related to insulation are shown and described below. Joe Swinford with EnergySEAL Air Barrier Systems LLC was instrumental in developing the design specifications for the method of installation.

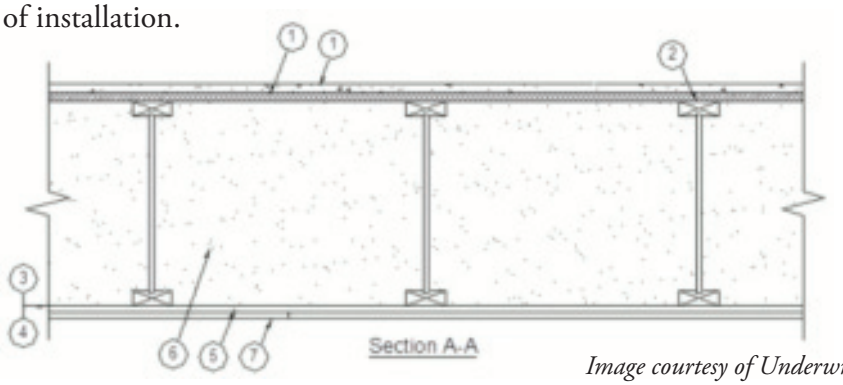

Image courtesy of Underwriters Laboratory

UL M512 describes a strategy of using fibrous, woven netting material (Item 3) and hexagonal wire mesh (Item 4) beneath a resilient channel (Item 5) to create a one hour fire-resistance rated floor. The wire mesh is fastened to the underside of each joist with staples, with side joints overlapped. This design creates a cavity where you can install GreenFiber cellulose insulation at a nominal dry density of 4.0 lb/ft^3, completely filling the plenum.

Renewable Energy

The solar electric system consists of 168 high-efficiency SunPower T5 solar roof tile photovoltaic (PV) modules (308 watts each), with a total capacity of 51.74 KWDC. There are 4 sub arrays on the roof connected to six grid tie SunPower inverters. The total roof area covered by the solar array is approximately 3,000 square feet or the equivalent of a 55' by 55' square. The expected yearly system production is around 75,000 kWh. The panels are ballast mounted (meaning no penetrations through the roof, which reduces risk of roof damage or leaks and minimizes installation time), and the system is grid interactive with no storage batteries.

Actual Installation in Mercy Housing Idaho

Materials

The team also achieved the maximum points for environmentally preferable products. The cement foundation contains 30% fly ash compared to the more standard ratio of 20% fly ash. The gypsum, insulation, concrete pavers, cabinets, interior doors and trim contain recycled content. In particular, the GreenFiber cellulose insulation contains 85% recycled content (55% post-consumer and 30% pre-consumer). The water supply piping is made from PEX, which is more cost effective than copper and has the flexibility of plastic yet is made with no chemicals so is safer for drinking water. Flooring by Armstrong and carpet by Bigelow is SCS FloorScore and Green Label Plus certified. Paints, coatings, adhesives and sealants were low-VOC, and it is specified in the O&M manual to adhere to these healthy standards for all maintenance. (It is worth noting that the projects that have used zero-VOC paint have been frustrated by the quality and performance, and all recent project have opted to use low-VOC paint.) All framing lumber, concrete, aggregate and insulation are local.

Image courtesy of Glancey Rockwell & Associates

STRATEGIES TO SAVE ENERGY

The 12th and River project is energy efficient, but doesn't have the highest HERS score out of the twelve projects. Valencia and The Grove at Riverside each achieved a 48 HERS score. The Grove (like 12th and River) opted to use GreenFiber insulation. The envelope specifications for both projects are slab foundation with R-15 edge and underslab rigid insulation, U-0.30 windows and insulation levels of R-60 for roof and R-21+ for walls. The Blower door test results came in at 2.67 ACH50 for The Grove, which is very good for multifamily projects. Valencia had higher infiltration rates. Heating is provided by natural gas furnaces with 0.93 AFUE and electric air conditioners with a 15.3 SEER. Valencia also selected gas furnaces, although with a little higher efficiency of 95%. Electric air conditioners are 13 SEER. (For a heating dominated climate like Idaho, it is probably a better investment to increase efficiency on the heating rather than air conditioning, and focus on controlling infiltration.) Ventilation is exhaust only in The Grove, and Valencia opted for HRVs. In both projects, one hundred percent of lighting is high efficacy and all appliances are ENERGY STAR.

As a general trend, most projects have high-efficiency gas furnaces for heating (94 AFUE plus), although some have opted for mini-split systems. This tends to be an urban vs. rural divide in which contractors are concerned about maintenance of any equipment that is not "tried and true" in a remote location. Duct sealing is a priority that everyone seems to agree upon, although several debates have occurred at design charrettes to weigh hard vs. flex ducting. There has also been discrepancy about tank vs. tankless water heaters as well as more centralized systems vs. unit-specific solutions. All appliances have been rated ENERGY STAR. Unfortunately, none of these projects have been able or willing to incorporate passive solar design. And, none of these projects have chosen to generate renewable energy on site for the units (but some have put in solar lights in parking lots or PV panels on community buildings).

Based on reviewing HERS scores on these twelve projects, there seems to be a penalty for all-electric systems. Although this is anecdotal and not scientifically proven, it appears that projects with gas heating systems tend to score higher on the HERS index.

THERMAL ENVELOPE STRATEGIES

Every project team emphasized the value of investing in a tight, efficient thermal envelope. Details were hashed out at design charrettes to combat thermal bridging and lower operating costs. For example, topics that have come up in design charrettes include using solid studs instead of ladder blocking at the corner of party walls and paying attention to the intersection where interior party walls meet exterior walls.

Some advanced framing techniques allowed greater insulation coverage (e.g., 24 o.c. floor or roof, sizing headers for loads, using ladder blocking and 2-stud corners). One issue with advanced framing is the ability of the electrician to properly space J boxes if kitchens are on exterior walls. The stud spacing is too wide to accommodate code requirements for electrical in kitchens, so extra blocking needs to be installed.

Although some single-family builders are doing staggered stud framing using two rows of 2x4 studs, the multifamily designers are sticking to conventional 2x6, stick-frame construction. Most are using blown-in insulation more often than batts, but few are willing to pay the higher cost for spray foam insulation. Windows tended to range from U-0.27 to U-0.30. A strategy that worked well was to assign overall air sealing (caulking and foaming all penetrations) to one subcontractor rather than leave it to several trades. The devil is in the detail when it comes to air sealing. Culprits of air leakage have been kick plates under cabinets and any

"late in process" installs such as an intercom. Another example of an important detail is when electricians tend to foam around J boxes, but the final step of caulking the drywall opening tends to be overlooked. It is also important to create a continuous boundary to separate units from corridor, such as a continuous top plate.

EFFICIENT LIGHTING STRATEGIES

The minimum threshold for lighting has been 90% high-efficacy (based on the Northwest ENERGY STAR threshold), and some have gone with 100%. Unfortunately, it still seems that LEDs are getting value engineered out in favor of CFLs regardless of the return-on-investment (ROI) and preferred light quality discussed during the design charrettes.

EFFICIENCY AND HEALTH

Project teams rarely question the value of good ventilation strategies per LEED/ASHRAE. More than half of the projects have energy recovery ventilators for continuous ventilation (many have opted for WhisperGreen products from Panasonic). And, occupancy sensors or automatic timers have been installed in bathrooms. Moisture control measures are taken seriously. None have chosen to upgrade to high-end filters with a MERV 13, instead opting for MERV 8. Most have chosen to have third-party performance testing of exhaust and supply flow rates, which seems to be appreciated as good quality control. Some have been able to schedule pre-occupancy flushes of the building for 48 hours, but this has been a challenge depending on the season and construction schedule.

WATER CONSERVATION

Most affordable housing project owners are interested in saving on long-term operating costs by conserving water. All pay attention to efficient irrigation measures, minimizing turf and installing drought-tolerant plants. This not only reduces water volume but reduces maintenance. Low-flow plumbing fixtures are standard. However, the degree of low flow depends on resident satisfaction. A toilet that is 1.28 gpf or dual-flush is acceptable, but 1.1 gpf has not been well received. Lavatory faucets are typically 0.5 to 1.5 gpm, and an aerator seems to be an acceptable way of reducing flow. However, very low flow showerheads (such as 1.5 gpm) or ones with aerators have not been well received. A flow of 1.75 gpm seems to strike the right balance.

None of these projects have been able to justify rainwater or greywater capture or reuse. It would seem that in a dry climate that this would be beneficial. But, the rainfall is significantly higher in winter than summer, so the storage needs are significant. And, there still seems to be a stigma about greywater reuse in Idaho. Few code officials seem to understand it. Few designers seem to see it as a priority to recommend. And, few owners seem to want it. In a state such as Idaho with rapidly depleting aquifers, opinions around this issue may have the potential to change in the future.

LESSONS LEARNED

Invest in design. There seems to be a lot of talk about an integrated design approach, and these project teams have all opted to have full-day design charrettes and continue with regular design meetings. The most successful technique has been to spend a half day with the primary designers on the project talking about strategies at a higher level, and weighing costs

vs. benefits with owners; and then spend a half day with the team of subcontractors discussing how the strategies will be implemented. This empowers subcontractors and often leads to design tweaks that are less costly than change orders.

Experience matters. Bringing on team members with LEED experience is very advantageous, and a LEED AP (Accredited Professional) Homes can help to streamline the process. An experienced LEED Rater can also serve as a very effective coach during construction. And, it is meaningful to differentiate based on the type of LEED experience. These projects are all LEED for Homes projects, while multifamily projects greater than 6 stories fall under LEED for New Construction (commercial). The credits, process and documentation are very different between residential and commercial LEED ratings systems.

Cost-benefit analysis. Point chasing is rarely a satisfactory way to pursue LEED certification. Instead, look at each credit as a possible best practice. Compare the cost and hassle to pursue it versus the benefits that can be achieved. And, do this during the design phase.

FINAL THOUGHTS

If you ask a developer, they tend to value the quality control that comes from having third-party inspections and performance testing. Architects seem to appreciate the integrated design process and the charrette in particular. Builders appreciate involving the subcontractors in design discussions and training, then having good support throughout construction to define responsibilities and provide coaching on best practices. Residents value all things related to health and operating costs.

To circle back to the developer who had chronic asthma as a child, his name is Tom Mannschreck, President and CEO of Thomas Development Co. He cites LEED as the new math in the development business, and appreciates the decreased resident turnover. He says "LEED seems to us to be the most holistic from pre-construction to construction and more importantly long term sustainability. Our affordable apartment communities are designed to operate as such for a period of 40-50 years… what you build needs to be for the long term."

Project	Location	HERS score	Year Built
Cardona	Chubbuck	85	2008
Rosslare	Idaho Falls	69	2009
Summerhill	Idaho Falls	52-55	2011
Bandon River	Idaho Falls	51	2014
Valencia	Fruitland	**48**	2015
Carlow	Rexburg	53	2016
Kinsale Place	Lewiston	54 (est)	2017
Vineyard at Broadmore	Nampa	67	2013
12th and River	Boise	56	2012
The Springs	McCall	n/a	2011
The Grove at Riverside	Rexburg	**48**	2015
Ross Island	Emmett	50 (est)	2017