Word On Windows

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Windows for Multifamily Housing

Single-family homes or duplexes typically attract the most attention from energy efficiency programs such as ENERGY STAR or utility rebates. Nevertheless, the importance of energy efficiency, including efficient windows, for multifamily housing is increasingly being recognized. The term multifamily is often understood to apply to buildings that consist of five or more housing units. These buildings make up about 18 percent of the nation's housing stock, and demand in this market segment is high.

Demand for Multifamily Housing

Multifamily housing has perhaps been one of the few relatively bright spots of the housing market this year and last year. The National Association of Home Builders forecasts that a slow but steady rise in multifamily construction will continue through 2012. This rise in construction is moderated by tight access to credit. As a result, demand for existing multifamily housing is high as well.

An economic reason for this demand is the interest in renting – common in the multifamily sector – due to uncertainty in home values, limited finances and the need for flexibility in the event of relocation. Home buyers have also grown more cost-conscious, and often find condos to be more economical than single-family housing in terms of purchase price, utilities and transportation costs.

Multifamily housing can also be a very attractive choice if the location is within vicinity to work, stores and entertainment and if the buildings are in good condition. The demand for higher-quality multifamily housing is driving efforts to refurbish existing multifamily housing and to design new attractive high-performance buildings.

Energy Efficiency Needed

Energy efficiency plays an important role in making multifamily housing more attractive and affordable. Although energy expenditures per person are usually lower among households living in multifamily buildings than among those living in single-family homes, average energy consumption per square foot of living space is actually higher than in single-family homes.

Thorough energy efficiency retrofits can achieve improvements of 30 to 75 percent in many multifamily buildings. On page 3, we present an example of such a deep energy retrofit. In most climates, hot and cold, efficient windows are central for boosting occupant comfort and reducing energy costs.

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ENERGY STAR and LEED for Multifamily Buildings

Both the ENERGY STAR and LEED designations for homes have found increasing uptake among multifamily buildings. These programs were originally designed for low-rise homes, including units in multifamily buildings with up to three stories, for which the same qualification criteria apply as for single-family homes. Both programs are now also being adopted for mid- and high-rise multifamily buildings, although different procedures may have to be followed for those.

ENERGY STAR Multifamily High Rise

Units in buildings with 4 to 5 stories can qualify for ENERGY STAR in the same way as low-rise homes if they each have their own heating, cooling and hot water systems. All other multi-family buildings multifamily with more than three stories, including those with central HVAC and up to any height, can now partake in the recently launched ENERGY STAR Multifamily High Rise program. This program

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ENERGY STAR and LEED *(continued)*

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awards the ENERGY STAR for performance that exceeds ASHRAE Standard 90.1-2007 by at least 15 percent or for compliance with a prescriptive path that sets requirements for equipment, distribution systems, lighting and the building envelope.

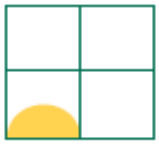
Under the ENERGY STAR Multifamily High Rise prescriptive path, windows must be either ENERGY STAR qualified or comply with the requirements of ASHRAE Standard 189.1-2009. All glazing must be double-pane with low-E coatings. The maximum allowable window-to-wall ratio is 30 percent.

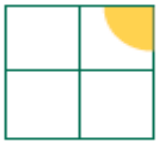
LEED for Homes Multifamily Midrise

Since October 2010, the U.S. Green Building Council (USGBC) offers a variant of LEED for Homes for mid-rise multifamily buildings with 4 to 6 stories, while low-rise dwellings are covered by the standard version of LEED for Homes. Like the ENERGY STAR Multifamily High Rise program, LEED for Homes Multifamily Midrise requires at least 15 percent energy efficiency beyond 90.1-2007. In addition, points have to be earned in various categories, such as sustainable sites, water efficiency, materials and resources, etc.

During the Greenbuild Conference and Expo in Toronto on October 4-7, USGBC will announce the winner of a Multifamily Midrise Design Competition. Architects are competing to design a new sustainable mid-rise building in combination with the gut-rehab renovation of an existing building in New Orleans. ■

Resources:
www.energystar.gov/mfhr
www.usgbc.org/leed/homes





High Performance Windows for Structural and Energy Performance

Windows for larger multifamily buildings often need to meet stricter structural requirements than windows for low-rise homes. Although this can somewhat limit the available options for superior energy performance, projects such as the Castle Square deep energy retrofit (see page 2) are taking advantage of windows that provide above-average energy performance and adequate structural integrity for a larger apartment complex.

The Department of Energy now makes it easier to find windows with beyond-code insulating performance and commercial-grade structural strength. Since 2010, the DOE High Performance Windows Volume Purchase Program has promoted residential windows with a U-factor of 0.22 or less through a web portal including product and vendor information. Since the start of the program's second phase in May 2011, it includes windows with CW and AW performance classes, according to the North American Fenestration Standard.

The program allows a somewhat higher U-factor for windows with these performance classes: The U-factor limit is 0.27 for operable CW class windows and 0.32 for operable AW class windows. These adjusted criteria reflect that the incremental cost of reducing the U-factor of windows with high structural performance can be steep. At any rate, these U-factor criteria substantially exceed code requirements for windows in commercial and high-rise residential buildings.

DOE High Performance Windows U-factor specifications

R and LC class:	U ≤0.22 for operable U ≤0.20 for fixed
CW class:	U ≤0.27 for operable U ≤0.24 for fixed
AW class:	U ≤0.32 for operable U ≤0.27 for fixed

Performance classes determined in accordance with the North American Fenestration Standard (NAFS) 2008

For more information on the DOE Windows Volume Purchase Program and on the applicable specifications, view www.windowsvolumepurchase.org. ■

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Boston Apartment Complex Showcases Energy Efficiency

As it currently stands, the 7-story brick box apartment complex in Boston's South End hardly strikes the onlooker as an example to be replicated. But this is set to change as the 192-unit Castle Square Apartments receive a deep energy retrofit that promises to elevate the city block's attractiveness, comfort conditions and energy performance to a higher level.

The building owners – Castle Square Tenants Organization and WinnCompanies – intend this energy efficiency overhaul to be an example that can be replicated among similar multifamily dwellings. The Northeast hosts one third of all buildings with fifty or more housing units, and many of these share similar needs and opportunities with Castle Square Apartments. Energy efficiency retrofits are a priority in this region, where buildings are usually older, winters are cold and long, and energy prices are high. Needless to say, lessons learned from this project would also apply to plenty of buildings in other regions such as the Midwest or Mid-Atlantic.

To be replicable, the project must be economically feasible and enhance the living space. The prospects for the Castle Square retrofit look good on both accounts. And the over 60 percent expected energy cost savings are something to write home about: we're not talking incremental here!

Making it Happen

How did the owners of Castle Square find the resources for this dramatic improvement? Financing is certainly as issue as 60 percent of the residents are below medium income.

For this project, timing is everything. A building like Castle Square Apartments tends to be renovated every 20 years to keep it in good shape. While energy efficiency is not the primary reason for a building overhaul, adding energy efficiency upgrades during renovation is far more affordable and less disruptive than implementing them individually at separate times. Since Castle Square was scheduled for renovation anyway, combining this with a deep energy retrofit simply made sense.

Castle Square Apartments before renovation
Photo courtesy of WinnCompanies

As an affordable housing complex, Castle Square is eligible for a federal Low Income Housing Tax Credit. This credit is available for new construction and needed rehabilitation, including measures such as window replacement. In addition, the project is taking advantage of funds from the Commonwealth of Massachusetts, utility programs, and $4.4 million dollars of federal stimulus funding. Although similar projects may not receive the same level of assistance – the stimulus funding is gone and state and utility resources vary –crucial support for affordable housing renovations is often available. The owners of Castle Square were also able to stretch the project budget by taking on debt, which will be repaid from the substantial energy cost savings.

The residents of Castle Square are the key drivers for the deep energy retrofit approach, making sure that thermal comfort, health and environmental sustainability considerations are addressed and that the expected energy savings materialize. The residents' input is important as the apartments remain occupied during the retrofit process.

Energy Savings

Energy costs for the 192 housing units of Castle Square Apartments are expected to drop from about $590,000 per year to about $230,000 per year. The most substantial savings stem from the reduced use of natural gas for water heating (by 78 percent) and space heating (by 71 percent). Electricity use for air conditioners, lighting, refrigerators and plug loads is anticipated to drop by 60 percent.

Wall, Roof and Window Upgrades

Most of the heating and cooling savings will be achieved with building enclosure enhancements, which will also help attain occupant comfort levels. The overall insulation value of the building enclosure will be increased about tenfold. This insulation boost is accompanied by air sealing, which contributes 40% of the projected heating savings.

An air and water control membrane and mineral wool insulation, protected by durable insulating metal panels, are being added to the outside of the main apartment building's uninsulated brick

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Tenants participate in a design charette
Photo courtesy of WinnCompanies

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walls. This boosts the wall R-value from R-3 to R-40; roof insulation will be doubled from R-20 to R-40.

Castle Square's windows are the weakest links in the old building envelope. The current aluminum double pane sliders with a U-factor of around 0.75 were poorly installed, allowing substantial air leakage around the frames. These are being replaced with fiberglass-framed casement windows with a U-factor of around 0.2. To ensure air tightness, the installation practices for the windows along with the wall insulation measures have already been tested in model units. The potential for thermal bridging due to the window installation was also carefully assessed and minimized. As an additional check for quality, 15 percent of the renovated units will be sampled with blower-door tests.

The new casement windows were chosen for their air tightness and ease of egress. Though relatively expensive, fiberglass was selected as frame material for being a well-insulating, dimensionally-stable and environmentally-friendly option. This choice concurred with the residents' preference for comfort and sustainability. The windows have low-solar-gain triple glazing. A higher solar heat gain coefficient (SHGC) was suggested by modeling of annual energy use, but models that took into account the comfort impacts of potential overheating advised for a low SHGC.

As a result of the substantial building shell improvements, much smaller equipment will satisfy the apartments' heating needs, substantially cutting the retrofit's overall cost.

Heating and Cooling Equipment

Old central boilers with 70 percent efficiency needed to be replaced. Due to the substantial shell improvements, tiny, 94.5 percent efficient boilers can supply the needed heat, with each boiler serving 16 apartments. Right-sizing the boilers based on a careful assessment of the heating needs will further improve system efficiency.

For cooling, Castle Square will continue to rely on through-the-wall air conditioners in order to leave individual residents with the ability to determine their own air conditioning intensity and costs.

Fiberglass window in renovated façade
Photo courtesy of WinnCompanies

Looking Ahead

The Castle Square deep energy retrofit started in December 2010 and is expected to finish in March 2012. Most of the building shell measures are being performed over this summer.

To communicate the lessons learned from this retrofit and encourage similar projects across the country, the Castle Square deep energy retrofit team shares its experiences at www.castledeepenergy.com. ■

Low-Energy Windows for Multifamily Buildings in British Columbia

Canada's Pacific province does not lack its fair share of optimism. "The Best Place on Earth", as British Columbia's government used to call it, has an Energy Efficient Buildings Strategy with the goal of reducing the average energy demand per home by 20 percent by 2020. Now, 20 percent by 2020 may at first sound like a neat play with numbers, but British Columbia is indeed taking very concrete steps toward this goal. Among these steps are comprehensive utility demand-side management programs and provincial government "LiveSmart" incentives, a revenue-neutral carbon tax of $25 per metric ton of CO_2 and codes for low-energy buildings, as well as standards for energy-efficient products, including windows.

British Columbia's energy efficiency efforts include a recent focus on multifamily buildings. It's an important market segment: In Vancouver, for instance, three-quarters of new housing has been multifamily over the past 30 years. To assess how the energy performance of multifamily buildings can be improved, building science researchers Graham Finch, Dave Ricketts and Warren Knowles of RDH Building Engineering studied the challenging segment of mid- and high-rise multifamily buildings. Their analysis of envelope heat losses in existing high-rises found that windows are a major factor. While RDH also identified several other important factors, let's take a closer look at their findings on windows and at the steps British Columbia is taking to improve window energy efficiency.

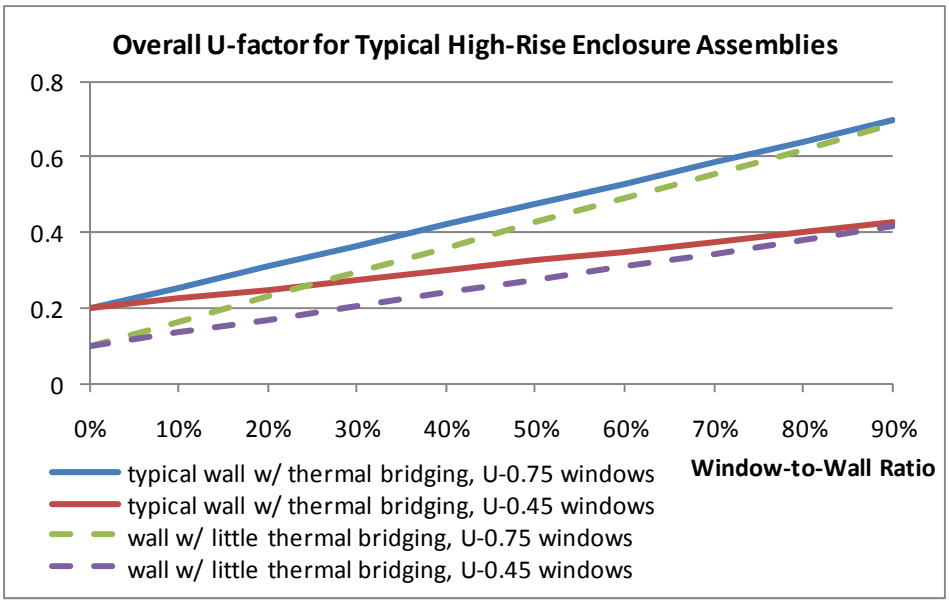
Windows in Current British Columbia High-Rises

About two years ago, the town Titled "The Path toward Net-Zero High-Rise Residential Buildings", the study by RDH looks at the construction practice for mid- and high-rise multifamily buildings in British Columbia and the potential for improvement. Even in Vancouver's relatively mild climate, space heating is typically the largest energy end-use in multifamily buildings. To assess heat loss, the thermal envelope performance of 13 representative buildings was modeled in detail using the thermal simulation programs THERM

5.2 and WINDOW. This included hundreds of wall, roof and window models based on original drawings while taking into account actual construction details, thermal bridging, and window and door sizes and frame configuration. This analysis includes both original 1980s enclosure conditions as well as the envelopes that have been rehabilitated in recent years.

Due to thermal bridging from steel stud framing, exposed slab edges and balconies, the overall performance of the original walls of the studied buildings is only about R-3.5 to R-5.5 (U-factor 0.18 to 0.29). Even after rehabilitation, the typical wall performance is no more than R-4.5 to R-7 (U-factor 0.14 to 0.22). As expected, though, the heat loss through windows is substantially higher. The typical 1980s buildings were built with dual-pane aluminum windows with neither low-E nor thermal breaks (U-factor around 0.75). Among the rehabilitated buildings, thermal breaks are common, but low-E was not ubiquitous before the BC window standards (see below). U-factors for newer aluminum frame windows range between about 0.45 for low-E windows and 0.6 for clear-glass windows. With window areas of 34 to 65 percent of the wall area, several of the study buildings lose about three times as much heat through their windows as through their walls.

Those buildings that were rehabilitated without low-E glass were deprived of an important energy savings opportunity. To ensure that such opportunities are not missed, British Columbia has recently started to require that all new windows must meet energy efficiency standards that essentially require the use of low-E glass (see info box). Simulations indicate that windows meeting the new standards should reduce space heating energy use in high-rise residential buildings by 5 to 10 percent if replacing typical clear glass windows without thermal breaks (or 2.2 to 4.4 percent of total building energy use, up to three times larger than replacing the lighting to meet the advanced standards). This does not take into account the air leakage reduction potential from new windows.



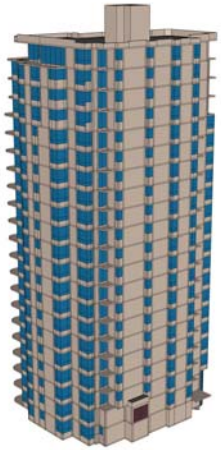
Toward Net-Zero Energy Buildings

Leading-edge engineering firms in British Columbia are exploring pathways toward the construction of net-zero-energy buildings by 2020. By then, the City of Vancouver intends that all new buildings use 50 percent less energy than today and meet the remaining energy demand from renewable sources. Stronger energy efficiency is supported by a foundation of policies contained in the 2010 *Clean Energy Act*, with oversight by the BC Ministry of Energy and Mines. Furthermore, the Homeowner Protection Office supports research and education initiatives for the residential construction sector, including the RDH research.

High-performance windows are an important element of deep energy demand reduction in high-rise residential buildings with high window-to-wall ratios. As suitable windows with low-conductance frames and triple glazing are becoming available for these building types, significant jumps in envelope performance can be achieved. RDH Building Engineering estimates that a thermally improved enclosure design with U-0.17 windows, walls with an effective R-value of about 18, airtight construction and 80% heat recovery on ventilation air can result in 50 to 90 percent heating energy use reductions as compared to typical current high-rise residential buildings. While not the only one, windows with superior performance are a crucial element of energy efficiency. ■

New British Columbia Window Standards

Over the last two years, British Columbia phased in maximum U-factor standards for new windows installed in existing and new buildings under the *Energy Efficiency Act*. This act started in 2009 with a 0.35 U-factor limit for windows in small buildings. In January 2011, similar standards were added for large buildings, such as residential buildings with five or more stories. These require U-0.45 for metal-framed windows and U-0.35 for non-metal windows.



Sketch-up of one of the study buildings
Courtesy of RDH Building Engineering

Windows for Multifamily Housing *(contd.)*

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Efficient Windows for Multifamily Housing

On average, the windows in existing multifamily buildings are less energy efficiency than those in single-family homes. Among multifamily housing units, more than half still have single-pane windows, as opposed to less than 40 percent in single-family homes. Surveys by the Energy Information Administration found that only about 10 percent of multifamily housing units have had some or all of their windows replaced.

Why this lag in window performance among multifamily homes? In many older, centrally heated buildings without adequate temperature controls, operable windows may be the only available thermostat during the winter, making the case for efficient windows less compelling. Moreover, most occupants of multifamily homes have little say over their windows. More than 80 percent of multi-family housing units are rented, leaving window choices up to property owners whose incentive to maximize window performance is less than that of a homeowner. Also, capital is often in short supply for multifamily buildings with low- and moderate-income renters.

Even in owner-occupied condo buildings, the process for replacing windows requires much more than just a trip to the local lumberyard. Particularly in larger buildings, the interests of multiple parties, as well as structural and potential historic requirements, must be taken into account. Yet these barriers do not diminish the role that window efficiency plays for heating and cooling energy use and for occupant comfort.

A wide range of window types are used across the multifamily sector depending on building location, size, height, façade types and architectural preferences. Energy-efficient options are available regardless of window type. In this newsletter, we introduce some energy efficiency programs such as ENERGY STAR Multifamily High Rise and the DOE High Performance Windows Volume Purchase Program, that encourage the use of energy-efficient windows across different types of multifamily buildings. ■

EWC Fact Sheet: High-Rise Residential Windows

A new Efficient Windows Collaborative fact sheet offers guidelines for specifying energy-efficient windows for mid- and high-rise multifamily buildings. This guidance includes recommended energy efficiency specifications that exceed most energy codes but can be met by commonly available windows.

View this and other EWC fact sheets at www.efficientwindows.org.


Efficient Windows Collaborative

Energy Efficient Windows for Mid- & High-rise Residential Buildings

www.efficientwindows.org January 2011

Energy-efficient windows save heating and cooling energy and improve occupant comfort while allowing for downsized HVAC equipment. Residential-type ENERGY STAR windows are a good choice for saving energy in single family and many multifamily buildings. However, structural, safety and façade design considerations in mid- and high-rise buildings often call for commercial-type windows which are not part of the ENERGY STAR program. Whichever the case, the simple guidelines presented here can help you specify energy efficient options from among the different types of windows used in mid- and high-rise residential applications.

1. Comply with Energy Code Requirements

Most jurisdictions base their building energy code on the International Energy Conservation Code (IECC). Residential buildings higher than three stories are covered by the IECC's commercial chapter, which references ASHRAE Standard 90.1 as a compliance alternative. Both the IECC and Standard 90.1 require that window energy ratings are determined in accordance with NFRC standards. *See "Window Energy Ratings" on the next page.*

2. Look for Well-insulating Windows

In all buildings, structural and safety considerations are often addressed with metal framing or metal reinforcement. Since this may impact insulating properties, energy codes usually allow some flexibility for window U-factors for residential buildings higher than three stories. Nonetheless, ask metal window designs can limit the conductivity of metal frames or boost the strength of non-metal frames—allowing the specification of windows with beyond-average insulating properties while meeting structural and safety requirements. *See next page for U-factor specification recommendations and for an overview of structural performance classes.*

3. Pay Particular Attention to Solar Heat Gain

Solar heat gain is a particular concern for mid- and high-rise buildings where shading is difficult to provide and some units may have their windows only in a single, unfavorable orientation. Building energy codes limit window solar heat gain coefficients (SHGC) in warmer climates. But even in colder climates, you may want to consider low-SHGC windows to prevent overheating, particularly with west-facing windows or large glass areas. Control of window solar heat gain can substantially reduce the required cooling equipment size. *See next page for SHGC specification recommendations.*

4. Limit Air Leakage and Ensure Proper Installation

Air leakage is a particular concern for higher buildings where windows are exposed to greater wind loads. Controlling air leakage requires not only that windows are tested to comply with the energy code's air leakage limit, but also that they are properly installed. Window installation is critical for an airtight fit, to avoid thermal bridging, and to prevent water penetration around the window. Field testing in accordance with ASTM E783 can evaluate both the window assembly and installation details for air leakage. Water penetration can be evaluated in accordance with ASTM E 1105.

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Visit www.efficientwindows.org for more information on the benefits of efficient windows, how windows work, how to select an efficient window, and what manufacturers provide efficient products.

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We're always interested in reporting on new developments in the residential and commercial fenestration markets. If you have something you would like to share with us, please contact Nils Petermann at ewc@ase.org.