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Energy-Efficient Multifamily Housing

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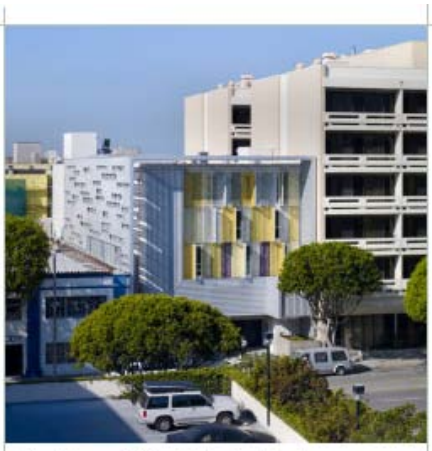


Step Up on Fifth in Santa Monica, California relies on passive heating and ventilation strategies to minimize dependence on energy-intensive systems for its single-room occupancy units.

Multifamily buildings are inherently green, thanks to the way they support denser, transit-friendly communities. No one makes that point more strongly than developer Jonathan Rose, who refuses to build anything on a site that wasn't previously developed. But, Rose argues, that's not enough. "Climate issues, biodiversity issues, energy security issues—all point to a dramatic need to reduce energy consumption. Anywhere we can find cost-effective savings, we should be doing that."

Multifamily projects are full of those opportunities. Uninsulated masonry buildings; antiquated heating systems; inefficient, ad hoc cooling—many aspects of typical multifamily construction and operation evolved in an era when energy was cheap. Today, solutions like using windows as thermostats in New York City apartment buildings no longer make environmental or economic sense.

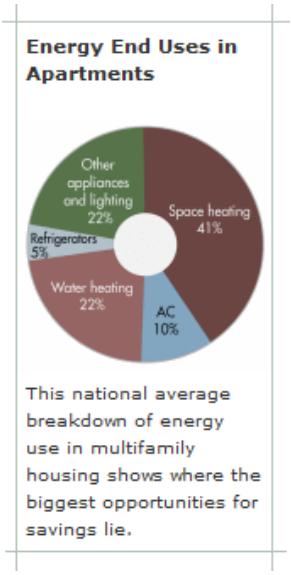
Seizing the opportunity, rating systems and labeling programs, including LEED for Homes and Energy Star, are expanding to better address mid-rise multifamily buildings, joining other excellent resources. Good public policy, market incentives, basic bioclimatic design, and new technologies all have a place in making our multifamily buildings greener.

The Big Opportunities

What differentiates multifamily from other medium and large buildings? Every unit has to have access to daylight and natural ventilation, so they tend to be more articulated than many office buildings, with a large surface-to-volume ratio. Residential buildings have more partitions, with the space inside subdivided into separate units and relatively small rooms. The occupancy patterns are different—with residents at home during nights and evenings, and sometimes all day. Multifamily buildings also use energy, water, and other services quite differently, using a lot of water, including hot water for cleaning and bathing. Here are six big opportunities for savings based on these and other unique factors.

1. Keep it simple

“We try to make our buildings simple to use,” says Lawrence Scarpa of Brooks + Scarpa in Los Angeles, noting that he’s learned the hard way: “Ten years ago we did a project with microturbines and solar panels, but how they functioned together was complicated.” After struggling with getting those complex systems to work right and keep on working, he says, “Now we try to treat our projects more like a VW than a Ferrari.”



This national average breakdown of energy use in multifamily housing shows where the biggest opportunities for savings lie.

To Scarpa, that means focusing on passive approaches such as daylighting, shading, and cross-ventilation. Brooks + Scarpa also gives as much control as it can to the residents, notably in features like the dramatic sun screens on the façade of the award-winning Cherokee Lofts.

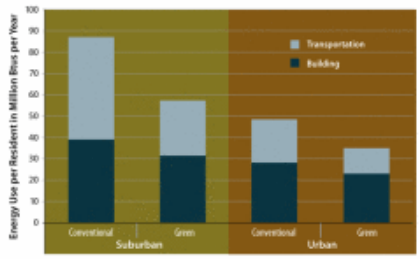
Trisha Miller of Enterprise Community Partners, a nonprofit focused on affordable housing, also recommends making the building do the work before bringing in the systems. “We recommend that people go by the energy pyramid,” says Miller. “Start with the envelope, then mechanical systems, and then, if it makes sense, add renewables.”

2. Use integrated design

Integrated design has been widely accepted in other areas of green design, but in multifamily, many teams are discovering opportunities to combine higher building performance with reduced construction costs. Recognizing this value, Enterprise has expanded the focus on integrated design with the release of its 2011 Green Communities Criteria. Enterprise also worked with several of its technical advisors—YRG

Sustainability, CTG Energetics, and 7group—to create the Green Charrette Toolkit, a free downloadable tool supporting best practices and resources to help facilitate a green charrette. Finally, Enterprise offers $5,000 grants to projects to help offset the cost of early design charrettes.

Energy Benefits of Transit-Friendly Location



Comparing conventional suburban houses with transit-friendly urban flats shows energy savings both in the building and in the associated transportation. These numbers are adapted from "Location Efficiency and Housing Type—Boiling It Down to BTUs," a report prepared for the U.S. Environmental Protection Agency by Jonathan Rose Companies. That report shows energy use per unit. In this chart those numbers are adjusted for different occupancy patterns based on the 2009 Residential Energy Consumption Survey demographic data.

The relatively large surface area of residential buildings, and the fact that each unit has operable windows and views, makes the building envelope especially important, and that's an area that requires interdisciplinary coordination. "Don't let the exterior or interior design teams get too far down the road without getting some input from the mechanical engineer or energy consultant," warns Bungane Mehlomakulu, P.E., principal with IBE Consulting Engineers in California. Mehlomakulu also notes that how the units will be owned and managed has a big impact on the viability of various systems. "All designers have to understand constraints such as who will pay the bills," he says.

The relatively high water use in multifamily creates good cross-disciplinary savings opportunities. The mixed-use Twelve West project in Portland, Oregon, for example, has both a vegetated roof and an oversized fire-suppression tank to reduce stormwater runoff. The roof gardens make the rooftop decks more attractive to residents, and the tanks also collect air-conditioning condensate during the summer, helping to irrigate the roof during the dry season. This system would not have made the cut if the developer hadn't managed to convince the city to reduce its connection fees based on the stormwater mitigation measures. That kind of coordination is possible only with an intensely integrated design process.

3. Combine heat and power

Many developers and building owners are attracted by the relatively low cost of natural gas and would like to generate their own electrical power, but power plants are not all that efficient unless you also have a need for waste heat. The large domestic water loads and 24-hour energy demand of residential buildings make onsite power generation with waste heat reclamation an attractive option—at least for higher-end buildings where the benefits of uninterrupted power can also be used as a selling point, notes Mehlomakulu.

The Dockside Green development in Victoria, British Columbia has an even greener solution: combined heat and power generated from waste biomass. The second phase of this planned 1.3 million ft^2 project opened in February 2011, claiming to be carbon-positive thanks in part to that system.

On projects that don't have the budget or technical sophistication for such combined heat and power, simple rooftop solar-hot-water systems are a good choice.

4. Capture waste heat

As insulation and air sealing reduce the amount of heat lost through the building envelope, ventilation air looms larger as an energy load. Ventilation actually includes two different kinds of energy loads: fan energy to move the air, and heating or cooling energy to condition the air coming in. For this reason many energy-efficient residential projects rely on heat recovery ventilators (HRVs), which extract heat from one airstream to warm another, or energy recovery ventilators (ERVs), which exchange both heat and moisture between an outgoing and incoming airstream. These devices, also known as air-to-air heat exchangers, come in many different forms and configurations.

HRVs have to be designed and installed carefully. Because they actually increase fan energy use, if they are not exchanging heat effectively, they will not actually save any energy. They also require periodic maintenance to sustain their effectiveness. But, especially in cold climates with large temperature differentials between indoor and outdoor air, they can save a lot of energy.

5. Central or distributed HVAC?

Which is the greener choice: highly efficient centralized heating or individual units that put residents in charge of their own heating bills? That's a key question that developers face on nearly every project as they try to balance first costs, operating costs, market appeal, and the psychology of resident behavior.

A conventional solution in many areas is central heating provided by the building, and cooling via individual window or packaged terminal air conditioners (PTACs) running off electricity that is billed to each resident. The problem is that these systems are difficult to control for heating and inefficient for cooling. There is also a huge air-leakage problem. The April 2011 report "There Are Holes in Our Walls," prepared for the Urban Green Council by Steven Winter Associates, estimates that on average each window unit has six square inches (4,000 mm^2) of leakage area, adding $130–$180 million to annual heating bills for New York City landlords and residents.

At Castle Square Apartments in Boston, a retrofit of a 192-unit, 1960s-era affordable housing project, the design team flirted with air-to-air electric heat pump systems that would have served blocks of 48 apartments each with heating and cooling. As Heather Clark of Biome Studio told *EBN*, they backed away from them for several reasons. The team felt strongly that having tenants pay for utilities was important to promoting conservation, and they couldn't find submetering technology good enough to work on these systems. The high first cost was also a problem, along with the high energy cost of delivering electricity. Those concerns ended up being enough to lead the Castle Square team to keep the window air conditioners, although they worked hard to find efficient units with a snug fit. Castle Square is now replacing its huge atmospheric boilers with small, efficient condensing boilers for heat and hot water. Jonathan Rose Companies is taking a similar approach in a 300-unit building in Newark, New Jersey, but they're looking into air conditioners that can be remotely controlled to some extent by building management to ensure efficient operation.

With construction set to begin in fall 2011, 803 Knickerbocker in New York City could be the first Passivhaus-certified apartment building in the U.S. The self-shading façade includes up to 12 inches of foam insulation.

In her design for the new 24-unit 803 Knickerbocker project in New York City, designed to Passivhaus standards, Chris Benedict, R.A. made a similar choice under somewhat different conditions. Benedict and her design partner, Henry Gifford, favor run-of-the-mill mechanical systems deployed in super-efficient ways. Their units are heated with tiny hydronic radiators supplied by a central boiler.

In typical Passivhaus style, ventilation is provided by HRVs in each unit, which also capture and reuse enough heat to keep demand on the boiler minimal. The HRVs also keep heat out in the summer; supplemental cooling in 803 Knickerbocker will be provided by window air conditioners. However, the AC units won't be installed at occupancy—their place in the wall is covered by an airtight glass panel. Residents will have to request the units from management, and "we're hoping that maybe people will be comfortable without them," says Benedict, who describes the building has having "a lot of thermal mass within a lot of insulation"—3 to 12 inches of foam provided via an Exterior Insulation and Finishing System (EIFS).
Related Companies has also been investigating submetering technologies that would allow it to distribute efficient, centrally provided heating and cooling while holding each tenant responsible for his or her own energy use. "We have seen data that suggests that when people pay for their own energy, they save 20%–30%," said Matthews. Related is working with a manufacturer in Asia on low-cost reliable Btu meters, but they aren't quite there yet.

The mixed-use MiMA development by Related Companies on the west side of Manhattan includes a hotel, theater, 500 rental units, and 150 condominiums. The designers anticipate 22% energy savings, thanks to smart value engineering after the real estate market collapsed in 2008.

On its Midtown-Manhattan MiMA project Related went with a 15 SEER hybrid heat pump running off water that circulated from a central system. In the heating season, that water is heated by boilers, which costs the building owners about $15 per month per unit, but saves the tenants $40. The heat pumps are reversible and sophisticated enough to provide cooling even with hot water in the loop, so individual units can get cooling during the heating season.

6. Engage the residents

“Behavior of the people who work in the building and the behavior of the residents have an enormous amount to do with how green the building is,” says Rose. Residential buildings are even more at the mercy of their occupants than most, however, because facility staff members are not in most of the units on a regular basis to monitor and correct wasteful situations such as leaky faucets or improperly closed windows. Engaging with residents and corralling their support are key to ensuring good long-term performance. Although resident engagement can’t be a one-time effort, working with new tenants as they move in is an important place to start. For affordable housing projects, Enterprise has developed two different tools to support these efforts: one is a set of customizable, printable Resident Engagement Cards that provide tips and information on green and healthy living. The second tool is a series of workshop materials on topics such as how to read a utility bill or how to test for leaks in a toilet, including slides, videos, and exercises that Enterprise calls its resident “Training in a Box.”

These resources are available for anyone to download from Enterprise’s website. Whatever the channel or medium, facility managers have to be creative and flexible to find ways to communicate effectively with tenants and ensure that the property lives up to its green potential.

Rating Green Multifamily

Where multifamily has been covered by prominent green building rating systems, it has been indirectly—until recently. LEED, Energy Star, the National Association of Home Builders (NAHB), and Enterprise Community Partners each have programs that offer new tools for project teams who want guidance on achieving high-performance multifamily, and benchmarking how they've done.

Before we discuss each of these programs, it's worth noting that none of these apply to *existing* homes or multifamily buildings—a building type that is still not covered by a major rating system. Some existing multifamily buildings are using LEED for Existing Buildings: Operations & Maintenance (LEED-EBOM), but major pieces are not a good fit. An Energy Star rating for existing multifamily buildings is currently prevented by the lack of a comprehensive national data set to feed the kind of statistical model that Energy Star Portfolio Manager uses to benchmark other building types such as schools and offices.

Energy Star for Multifamily

As of June 2011 the U.S. Environmental Protection Agency (EPA) is offering the Energy Star Multifamily High-Rise program, following a pilot period extending back to 2005. Energy Star for Homes has been certifying units within low-rise buildings, and some 4–5-story buildings as long as they have in-unit HVAC and domestic hot water systems, but that has not worked for multi-unit buildings with central HVAC. Ted Leopkey, at the Energy Star Residential Branch in EPA, says that the multifamily program combines pieces of the Homes and the Energy Star commercial programs. Like the Homes program, it awards the "Energy Star" to buildings as an "asset"—how they are designed and built, not how they are operated. However, like the commercial program, it also requires owners to benchmark their performance using Energy Star Portfolio Manager. This benchmarking doesn't come with any additional awards (or penalties for skipping it), but Leopkey says, "We want building owners and managers to understand that the way you use the building is as important as the energy conservation measures that are built into it"—and he says that owners get it.

Projects can earn the Energy Star for achieving 15% energy savings above ASHRAE 90.1-2007. The pilot program called for 20% savings above ASHRAE 90.1-2004—Leopkey says that, given updates to ASHRAE 90.1, they figure the benchmarks are similar. On setting the target, he says, "We wanted to make sure that all the energy conservation measures used to achieve that performance target would pay themselves off within their useful life." Buildings in the pilot program achieved 20% savings cost-effectively, according to Leopkey, and one project got to 44%.

The savings called for in the Energy Star program are based on modeling, which takes place using ASHRAE 90.1 Appendix G protocols in concert with multifamily high-rise modeling guidelines developed by Energy Star. Leopkey notes that savings are not only modeled but also verified during construction.

Projects can choose a prescriptive path, using a package of energy conservation measures developed for the program, or a performance path, in which teams can choose their own measures (along with some prerequisites) and use modeling to hit the savings target.

LEED multifamily rating systems

Major Multifamily Green Rating Systems

Program component	Energy Star	Green Communities	LEED for Homes Multifamily Midrise	National Green Building Standard
Fees	None	None	$1,050 registration; $0.045/ft² review	$500 registration plus per-unit fee
Onsite verification	Professionally validated submittals include onsite testing	Technical advisor visits 10%–15% of projects	Blower-door testing and other inspections	Credits are field-verified, including performance testing
Scope	New construction or major rehab	New construction, substantial rehab, or moderate rehab	New construction or major rehab	New construction and major remodels
Location component	Focused on energy use within building	Separate tracks remove some credits that don't apply based on setting	Rewards urban settings with credits for density, access to services	Rewards urban settings with credits for density, access to services
Certification levels	One	One	Four	Four
Post-certification data reporting	Projects commit to benchmarking through Energy Star Portfolio Manager	Projects sign utility release form so ECP can get data from utility	None	None

Apartment buildings with 4–6 floors have until recently occupied a doughnut-hole within LEED. Their height and central HVAC systems keep them out of LEED for Homes, but they aren't tall enough to fit into LEED for New Construction (LEED-NC). (Many mixed-use projects have been eligible for LEED-NC.)

Now, USGBC has a rating system to bridge the gap: LEED for Homes Multifamily Midrise. The rating system is still in a pilot phase, but it has been stable since 2010, and Kelsey Mullen, director of residential business development for USGBC, told *EBN* that no changes were planned for it before it becomes official. Mullen says that the number of projects already certified measures in the dozens, with dozens more registered and more signing up regularly.

According to Mullen, LEED for Homes Multifamily is most similar to the regular LEED for Homes system and is delivered through the same network of providers and raters performing field inspections. It differs most strongly in energy: while low-rise homes (1–3 stories) use the HERS Index to benchmark their energy performance, mid-rise multifamily projects use ASHRAE 90.1, like LEED-NC—but with the multifamily adaptations developed by Energy Star. The multifamily system also includes some credits not in the single-family version, such as a credit for compartmentalization of units.

With the onsite inspections and collaboration with the rater that characterize LEED for Homes, the mid-rise program appears likely to foster the same alignment between modeled and as-built systems as Energy Star. LEED, of course, is not just about energy: as with LEED for Homes, the multifamily system has other credits that cover water efficiency, location efficiency, indoor air quality, and more, along with the "home size adjuster," which penalizes larger homes.

National Green Building Standard

Energy Star and LEED Programs for Residential Properties

		Energy Star		LEED*		
		Homes	Multifamily	Homes	Homes: Multifamily Mid-Rise	NC
Single-family detached		X		X		
Multifamily 1–3 stories		X		X		
Multifamily 4–6 stories	In-unit HVAC	X		X (4 stories)		
	Shared HVAC		X	X	X	
Multifamily 7+ stories			X			X**
Any dwelling not being built or rehabilitated		Not eligible for Energy Star or LEED for Homes				

The National Green Building Standard, developed by NAHB and also known as ICC-700, differs from Energy Star and LEED in that it is one standard that can be applied to homes of all sizes, from low- to high-rise. Kevin Morrow, program manager for NAHB, says that the standard has been applied to multifamily developments, although he couldn't confirm how large.

ICC-700 calls for 15% savings, at a minimum, over a home that minimally complies with the 2006 International Energy Conservation Code (IECC). Morrow says that as currently written, ICC-700 does not have unique measures applying to multifamily, such as the compartmentalization addressed in Energy Star and LEED.

Enterprise Green Communities

In 2010, Enterprise Community Partners turned its Green Communities Criteria into a formal certification program, which is already being cited in state-qualified allocation plans for low-income tax credits, according to Miller. The certification, which is available at no cost to developers, involves two steps—an initial application before construction begins and a final review after it is completed. Based on the initial review, Enterprise staff select 10%–15% of the projects for onsite assessments by a technical advisor. This engagement with an expert is more of a coaching relationship than an auditing one, says Miller: "We thought that onsite verification might be perceived as onerous, but we're seeing project teams request verification."

Compared to LEED, Green Communities is less expensive and less onerous to document, although it lacks—at least for now—LEED's brand value in the market, according to developers. Where LEED-NC requires commissioning and LEED for Homes requires that every project engage—and pay for—a provider who does site visits and verifies conformance with the standard, Green Communities covers that cost for the 10% to 15% of projects that get site visits. Jonathan Rose Companies uses Green Communities certification on all its projects. "It's designed with multifamily in mind, focuses more on behavior, and is cheaper to use," Rose says.

To date, 42% of LEED for Homes certifications, and about a third of new projects coming into the system, are for affordable housing projects. With that statistic in mind, Green Communities can be seen as a potential competitor to LEED, although Miller points out that Enterprise collaborates closely with USGBC and aligns its requirements with LEED to minimize redundant work. Enterprise has even published a table showing how the Green Communities points line up with LEED for Homes.

From the USGBC side, the good will is equally strong: "We're very supportive of Green Communities," Nate Kredich, senior vice president for residential, told *EBN*. With their free offering, "They are targeting projects that couldn't otherwise afford certification." Kredich adds, "Maybe LEED wouldn't be an option for those projects." Both organizations agree that LEED has a more robust verification program, however, with its

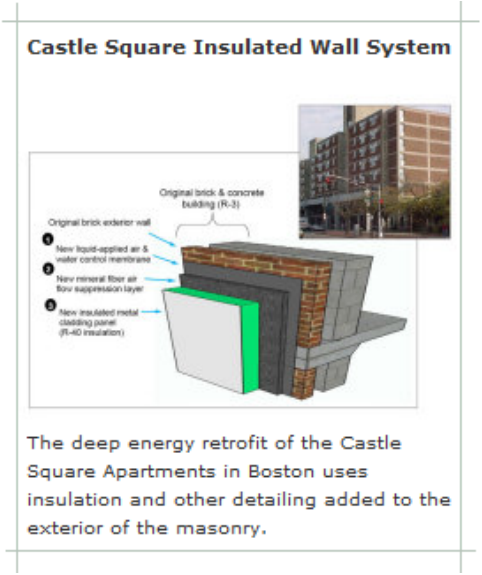
network of green raters, and are interested in ways to make that level of verification accessible to more projects.

Paying For It

Those who have done it report that energy-efficient multifamily is affordable. A partner with the Blue Sea Development Company in New York City, Les Bluestone says that his group has completed three multifamily high-rise buildings in recent years, all earning Energy Star and LEED Platinum certifications through those respective multifamily programs.

Bluestone says that both programs have brought some extra costs, which has put the company “between a rock and a hard place” because most of its work is for low- to mid-income renters, who have no flexibility with rents. In spite of the added costs, he considers the certifications “the right thing to do,” and he says they have been a loss leader in selling and renting apartments. It doesn’t hurt that incentive programs help cover the marginal cost of achieving Energy Star status. The attention to detail brought by blower-door testing, compartmentalization, and other measures has been beneficial, he says, and the company gets fewer maintenance requests on those buildings, and fewer heating complaints—a real cost-saver.
Lawrence Scarpa has learned how to work with the unique economics of affordable housing projects. These projects have a fixed budget with no flexibility, so the developers tend to set aside a large contingency budget in case of cost overruns, he explains. But they are also working with use-it-or-lose-it tax credits. “We have gotten good at minimizing change orders,” Scarpa says, “so we have money left near the end of the project.” To use those remaining funds, they have a whole green interiors upgrade package that can be inserted late in the construction process.

When it comes to retrofits and renovations, “it’s easier to finance the greening of multifamily than single family, since the benefits are very quantifiable,” says Rose.



The deep energy retrofit of the Castle Square Apartments in Boston uses insulation and other detailing added to the exterior of the masonry.

Federal stimulus funding to the tune of $4.4 million helped make energy-related improvements possible on the Castle Square retrofit in Boston, but Heather Clark of Biome Studio makes the case that the work is inherently feasible from a cost perspective. “If you’re going to be doing a renovation anyway, it’s the perfect time to be doing this kind of work,” she says.

By adding R-40 insulation to the outside of the building in the form of insulated metal-clad foam panels, the project is avoiding $300,000 in masonry repairs. By replacing kitchens and baths—work that was overdue—

the team is able to complete air-sealing details that would otherwise be inaccessible behind cabinets and fixtures, and which account for about half of the projected 70%–80% energy savings over a conventional project.

Adding insulation to the exterior, a solution that building scientists favor for masonry buildings, and doing interior work in discrete daylong increments, allows the building to stay occupied, saving millions of dollars in relocation expenses and rent. “In an occupied rehab doing interior insulation is basically impossible—the amount of dust the drywall creates is substantial,” Clark says.

Some work, like new windows and HVAC, would have been done anyway. The focus on energy helped push the project to more efficient solutions than it would have otherwise been able to afford, such as R-5 fiberglass windows—and it is that kind of extra push that the stimulus funding helped pay for.

The importance of an efficient building enclosure to realizing savings is echoed by Benedict, who says that she has designed 803 Knickerbocker to Passivhaus compliance without added costs. “We are pulling money out of the mechanical system, which has been reduced, and putting it into the enclosure,” she says.
The mammoth MiMA mixed-use development was close to breaking ground when the market collapsed in 2008. Related Companies managed to keep the project alive but only after cutting 20% out of its budget, according to Charlotte Matthews, Related’s vice president of sustainability. Some of those savings came from renegotiating labor contracts. For the rest, Related focused on value engineering rather than simple cost-cutting, and in the process improved the project’s projected energy performance by 20%. How? “Engineers rarely believe a developer when he says that he wants an energy-efficient building,” says Matthews. “But when they saw that we were still protecting the energy-efficiency measures through the value-engineering process, every time it was redesigned, it became more efficient.” During the redesigns a level of communication and trust was established that allowed the designers to really work together to optimize the systems.

It didn’t hurt that both federal tax deductions and utility incentives were on the table. As various energy-efficiency measures showed up on the chopping block, Matthews made sure that they ran through the energy model, which found, in many cases, that removing them was foolhardy. They learned, for example, that the heat exchanger would be paid for entirely by the incentives. And switching from halogen to LED lighting in the public spaces added $60,000 but saved about $100,000 annually in energy alone, before factoring in the labor savings from reduced lamp replacement.

Cost-saving opportunities even emerged during construction, as Matthews convinced the electrical contractor to string up compact fluorescents instead of incandescents for job-site illumination. Related promised to cover the cost of any stolen lamps (there were none) while the electrical contractor reaped the benefit of not having a full-time person devoted to replacing lamps. Over 400 days of construction the project saved $300,000 in electricity bills.

Next Steps

Getting to 20%–25% better than code in energy savings is quite feasible in today’s market, especially with the range of incentives and subsidies available to multifamily developers. But even doing that requires a well-integrated process and a focus on making efficiency a priority. Going beyond that requires active participation of residents and building managers. Few projects have put all that together yet, but many are making progress. More power to them.

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