An Integrated Whole Building Diagnostic Approach to Improving California's Existing Multifamily Buildings

Julieann Summerford and Elizabeth McCollum, Heschong Mahone Group, Inc.

ABSTRACT

With more than three-quarters of California's homes and apartments built before the 1982 Building Standards, and despite ratepayer-funded program efforts to target existing multifamily buildings, studies show that substantial opportunities remain to cost-effectively improve the efficiency of existing buildings.

Energy efficiency programs in California that target existing multifamily buildings typically offer a menu of incentives to replace equipment, appliances, or lighting. Little exists in terms of programs and guidance for owners to take a comprehensive and integrated approach to identifying measures or systems yielding the greatest energy savings specific to the building's design, orientation, and climate zone.

AB549 charged the CEC with targeting existing buildings which resulted in identifying trigger points and strategies, including whole building diagnostic testing and repair and assistance to affordable housing.

Since 2002, the Designed for Comfort (DfC) program has provided multifamily building owners guidelines and incentives for an integrated design approach to identifying the most cost effective energy efficiency measures. Interest in the program has resulted in a waitlist of units and turned away market rate multifamily building owners.

This paper will describe how the DfC program provides a mechanism for whole building analysis, addresses the CEC strategies, highlights the successes, challenges, and lessons learned over 3 funding cycles, as well as makes recommendations for expanding this effort to supplement existing prescriptive programs across all existing multifamily buildings. The paper will also propose strategies to expand this type of program to all multifamily buildings and tailor building simulation software to existing multifamily buildings. This strategy helps to create new markets for energy consultants and HERS raters and give owners a better understanding of the energy use in their buildings.

Background

Minimally touched by California's evolving energy code until the 2005 code, multifamily builders were disadvantaged in terms of being able to predict their project's energy savings due to several energy code loopholes, getting undo credit for measures typical in multifamily buildings. For example, central water heaters were compared against a standard individual water heater, and low amounts of west-facing glass were compared to a baseline of 20% west-facing glass. Through the 2001 energy code, multifamily developers could easily exceed building energy efficiency requirements by 20-30% through "phantom savings." The 2005 energy code updates closed these loopholes and began to address existing multifamily buildings, requiring certain upgrades and inspections to compliment HVAC equipment replacement.

While utility programs have long targeted multifamily buildings, many opportunities are lost because building owners have little incentive to replace inefficient equipment. Unless

equipment is broken or the building owner pays a portion of the utility bills, multifamily building owners tend not to invest in energy efficiency measures where tenants reaps the benefit of lower utility bills. Further, past attempts to achieve energy efficiency in affordable housing buildings through Low Income Home Energy Assistance Program LI-HEAP programs have been limited to "weatherization" types of measures, lighting, and appliances, leaving little incentive or assistance for pursuing larger energy efficiency upgrades through an integrated set of measures. While weatherization, lighting, and appliances contribute to energy savings, they are limited in that they do not address building performance as a whole.

The opportunity for energy efficiency upgrades coincides with the sale of a property, when equipment fails or is being replaced, or in conjunction with a rehabilitation effort. Rehabilitation frequently consists entirely of cosmetic or structural improvements - without even considering energy efficiency. Further, if equipment or building components that would impact energy efficiency are being replaced, the least costly replacements are often selected because the lifecycle cost or energy savings impact is not thought through. Typical multifamily buildings are rehabilitated no more frequently than every 10-15 years, and for the most part, it is only at these times that major changes to the building envelope are feasible.

These issues make for a substantial opportunity to improve energy efficiency in existing apartments, condominiums, and townhouses. While on average, multifamily dwelling units each use only 60% as much energy as a single-family home, which uses approximately 4,000 kWh each year, multifamily buildings comprise about 31% of California's existing residential housing stock.

In this paper, we will present a California program aimed at targeting existing affordable multifamily buildings through a comprehensive whole-building analysis strategy and the lessons learned through implementing this program. We will also propose how a similar effort expanded to all existing multifamily buildings could provide a comprehensive building analysis option to developers and meet California's AB 549 directive to target existing buildings using a comprehensive and diagnostic approach. We will investigate various modeling tools such as predictive energy simulation programs, benchmarking, and actual energy use. We will discuss contributing factors to successful implementation, such incorporating and defining protocols for the HERS industry and bringing the energy consulting industry into the existing buildings market. Finally, we will propose further action to address financing options, marketing opportunities, and coordinating with green rehabilitation and other programs.

Efforts to Date

Utility programs addressing the existing multifamily market are of two efforts:

- A prescriptive program offering incentives for a menu of energy efficiency measures for dwelling units as well as common areas
- "Weatherization" services for low-income housing.

The prescriptive program measures vary by utility, but largely consist of lighting, HVAC systems, insulation, domestic hot water (DHW), windows, and appliances. Some utility programs offer incentives for cool roofs, water saving features such as faucet aerators and low-flow shower heads, and/or common area measures including exist signs, lighting, and pool pumps. These programs are available to all multifamily projects – affordable and market rate,

and are appropriate for replacement of failed equipment and quick fixes not associated with a building rehab project. Prescriptive programs typically report deemed energy savings, estimated based on an average across sample projects, which may or may not match the group of participating projects.

Low income weatherization programs[1] are valuable in that they target affordable housing, but the programs vary by utility. Generally speaking, they offer energy-related home repairs, weather stripping and caulking, blower-door guided air sealing, heating system safety tests, repairs and tune-ups (and replacements for safety reasons), duct insulation and sealing, attic insulation, and hot water savings measures (insulation blankets and low-flow showerheads).

While there is a an assessment element to the weatherization programs, in that they conduct a visual inspection, equipment check, and possibly a blower door test, they do not conduct a comprehensive analysis to consider one measure's impact on another and the combined impact of various measures. Weatherization measures are often a portion of a utility's low income program**s**[2] which offer additional services such as lighting, cooling, and appliances. However, these programs are not available to market-rate, rental building owners.

While these programs play a critical role in encouraging owners of existing affordable multifamily buildings to improve efficiency, they are limited in the measures they include, do not allow the building owner to assess the combined effect of multiple improvements and may not consider the effectiveness of one system if synergistic systems are not upgraded together.

Comprehensive versus Prescriptive

A comprehensive approach is not a one-size fits all answer for existing buildings. Certainly, a prescriptive approach is appropriate for circumstance where there is limited budget, equipment fails and needs immediate replacement, or where a more substantive rehabilitation of the building(s) is not feasible (either timing, budget, or historical designation limitations). A comprehensive building analysis is applicable for when projects undergo more substantial rehabilitation or when the project owner wants to achieve a certain goal (such as a 25% improvement in energy efficiency), or wants to determine the impact of the interaction of measures such as replacing windows and the possibility of being able to reduce air conditioning equipment size. As evidenced in previous DfC participants, combining a prescriptive and comprehensive approach is not only feasible, but helps to maximize energy savings and incentives, but also to further leverage other funding.

AB 549 to Target Existing Buildings

California's AB 549, adopted in October 2001, directed the California Energy Commission (CEC) to target the existing building stock. As a result of this legislation, the

[1] Weatherization professionals perform a thorough home energy assessment to identify house-specific deficiencies and opportunities for energy conservation. An assessment may include a visual inspection, diagnostic testing on the building envelope (walls) and air distribution system to find where air is currently leaking out, checking the efficiency of heating and cooling equipment and for potential health hazards such as appliance that may be leaking carbon monoxide - http://www.csd.ca.gov/FAQs/Weatherization%20Assistance%20FAQs.aspx

[2] SDG&E's Energy Team Program http://sdge.com/residential/assistance_servicesEnergyTeam.shtml; PG&E's Energy Partners Program: http://www.pge.com/myhome/customerservice/financialassistance/energypartners/; SCE's Energy Management Assistance Program http://www.sce.com/RebatesandSavings/incomequalified/EMA/; SCG's Direct Assistance Program: http://www.socalgas.com/residential/assistance/dap/index.shtml

CEC's report "Options for Energy Efficiency in Existing Buildings" (CEC 2005, 19-40), outlines a strategy for targeting existing buildings (both residential and non-residential) that includes four key strategies for residential buildings:

1) Integrated Whole Building Diagnostic Testing and Repair which entails a comprehensive diagnostic evaluation of the building considering the combined effect of multiple improvements
2) California Home Energy Rating System (HERS) program – which will provide HERS Ratings for existing buildings to establish existing conditions as well as cost-effective recommendations for improving energy efficiency
3) Information Gateway – which will direct the utilities to provide education and referral services for multifamily building owners and managers to audit resources and program incentives and services (which could include HERS Ratings)
4) Assistance to Affordable Housing – which will provide technical assistance and training, funding for HVAC tune-ups and HERS Ratings, require energy efficiency upgrades to qualify for public funding and at time of rehabilitation, require housing authorities to offer a lower utility allowance for energy efficiency projects

Soon after AB 549 was passed, and prior to publication of the CEC report, HMG began implementing a program tailored to the affordable multifamily market that incorporates these strategies as well as additional strategies that could be applicable to the affordable and market rate (both for sale and rental) multifamily market.

An Integrated, Whole-Building Approach - How this Approach Meets AB 549 Goals, Maximizes Energy Savings

Since 2002, the Heschong Mahone Group Inc. has been implementing a third-party program that targets existing affordable multifamily housing by offering an integrated, whole-building approach to auditing and identifying the most cost effective heating, cooling, and water heating measures. The Designed for Comfort (DfC) Program, while currently targeting only affordable housing building owners, addresses the four strategies outlined by the CEC above and is easily applicable to all multifamily building owners.

The program aims to transform the multifamily retrofit market away from a prescriptive, one-size-fits-all approach, toward a comprehensive building analysis approach that uses energy consultants and HERS Raters to evaluate a wide palette of energy efficiency options when rehabilitating multifamily properties. DfC, a performance-based program, targets older existing affordable multifamily building owners and through design assistance and cash incentives, and requires energy efficiency improvements of at least 20% over existing conditions.

The DfC program provides a mechanism (incentives and technical assistance) to affordable housing owners to achieve a comprehensive building analysis approach using energy consultants and HERS Raters to analyze and verify a variety of energy efficiency options for rehabilitating multifamily properties. In addition, once rehabilitation is complete, the property managers receive EnergySmart Paks for each tenant unit. The EnergySmart Paks contain items such as two (2) CFLs, a low flow showerhead and a faucet aerator for additional gas and electric energy savings.

The objective of the program is to promote an integrated, cost-effective package of energy efficient measures with long useful lives (18 years on average) to achieve maximum long-term energy savings. Measures include high performance windows, improved insulation, and high-efficiency heating, cooling, and water heating equipment[3]. These measures, while individually capable of greatly reducing home energy needs, when considered in combination, can make greater impacts more cost effectively.

DfC offers incentives to partially offset costs to install or replace measures needed to achieve a 20% reduction in energy use. The program also provides incentives for energy consultants and HERS raters to increase their expertise and presence in this hard-to-reach market. Energy savings for each project is calculated using an approved program (e.g., EnergyPro, MICROPAS, or other) and installation is verified by a HERS rater before payment of incentives. The program offers training to owners and property managers on the performance-based approach and training to tenants on the proper use of their upgraded apartments.

Through a process of audits[4], building simulation modeling, inspection/verification, and training, the program takes on an integrated, whole building approach to identify the most cost-effective measures and to capture the combined performance of multiple measures impacting heating, cooling, and water heating. This analysis is conducted through the use of building simulation software (most often EnergyPro) to allow the energy consultant to:

- Consider the combined effect of multiple improvements
- "Trade off" different measures
- Tailor the recommendations that yield the most energy savings for the least cost on a specific project.

DfC requires a HERS rater to conduct an audit or inventory existing conditions from which baseline energy usage is established. The existing conditions are used in a building simulation software (typically EnergyPro) which entails identifying baseline usage and investigating trade offs to achieve a 20% improvement and selecting the most cost effective measures specific to the projects needs and budget while yielding the most energy savings. Two buildings of similar size, vintage, and mechanical systems may require different upgrades to meet 20% improvement. Upgrading insulation and windows may lower heating and cooling loads enough to meet the 20% target in one building, while the other building gets the most energy savings through replacement of hot water heaters and wall furnaces. In addition to allowing for the most effective set of measures to be selected, whole-building simulation estimates project-specific combined energy savings, rather deemed savings.

The program also serves as an information clearing house as well as providing design assistance support. The design assistance largely comes from working with the energy consultants who have only used EnergyPro for new construction projects. DfC provides multifamily building owners with a list of energy consultants and HERS Raters who had interest in and experience with existing multifamily builders. Additionally, the program serves as an educational tool for both the building owner and the tenants in that

[3] Because the utility programs offered incentives for appliances, lighting, and common area measures, the DfC program could not duplicate these measure incentives. Further in this paper, we discuss expanding this program to include these measures.

[4] The current DfC program does not include diagnostics, but further in this paper, we discuss including this as a more comprehensive strategy to assess opportunities to save energy for the least cost.

- The building owner gains a better understanding of the building and its energy performance and the interaction and impact of combined measures.
- HMG holds a workshop for the tenants after the energy efficiency rehabilitation was complete to inform them of the improvements, and provided information on an installed "EnergySmart Pak" that contained 2 CFLs, a low flow shower head, and a faucet aerator along with information and a discussion about how to further conserve energy in their homes.

Designed for Comfort was primarily designed for the multifamily market and specifically designed to meet the needs of the affordable multifamily market by providing energy efficiency rehabilitation design training, an affordable housing energy efficiency handbook, and providing examples of financing models that leveraged program funds to gain redevelopment funds or compete for public funding. The program coordinated with existing weatherization and assistance programs and encouraged building owners to take advantage of the free services first or in addition to the DfC measures and incentives. In several cases, the project would take advantage of weatherization or other utility program services which were above and beyond the DfC qualified measures and ultimately resulted in additional savings. Several projects leveraged the DfC incentives and performance criteria to receive additional funding from their local redevelopment agencies and housing authorities (which required some matching funds and competitive points for energy efficiency. Other projects applied for Low Income Housing Tax Credits (Tax Credit Allocation Committee – TCAC for California funds) which requires a 25% reduction in energy use on a per square foot basis in order to receive competitive points. Many TCAC applicants are at a loss in how to determine that their buildings reduce energy by 25% and DfC has provided not only a mechanism for this comprehensive analysis, but also supplemental funding to help offset the cost of the replacement upgrades.

The DfC program has long worked with housing authorities to adopt lower utility allowances for both energy efficient rehabilitation and new construction, allowing affordable housing owners to charge slightly more rent without increasing the total housing burden on the tenant. The utility allowance equation is rent plus utilities equals "housing costs." Utility allowances are set based on an average of predicted or a sampled consumption by unit size (number of bedrooms) and their energy systems. Because this is an average of all buildings regardless of vintage, it makes sense that a lower utility allowance would be more appropriate for buildings that have invested in energy efficiency and can quantify predicted energy savings. The lower utility concept simply tweaks this equation whereby energy efficient projects apply a lower utility allowance thereby allowing the owner to collect higher rents without changing the housing costs. However, housing authorities feel more comfortable about adopting an Energy Efficiency-Based Utility Allowance (EEBUA) for new construction, than for existing rehabilitated projects because of their perceived negative impact on existing tenants of "raising their rents." The Department of Housing and Urban Development (HUD) has endorsed EEBUA for new construction, but not for existing buildings due to uncertainty about the amount of energy that will be saved and the varying baselines from which projects start versus the "averaged" utility allowance.

Where Do We Go From Here?

Through 5 years of experience implementing the Designed for Comfort program and other performance-based programs for multifamily housing, HMG has discovered numerous opportunities and opportunities for improvement. We hope future programs will take a more comprehensive approach and address more building components, offer further educational services to ensure proper use and maintenance of the building, and develop software tools to streamline the program process. Additionally, evolving the training and certification of HERS Raters and energy consultants to address the existing building stock will greatly expand program potential and participation. While DfC has been successful in the affordable housing market, from our lessons learned and without budget constraints, we feel this program could be more comprehensive in scope if a building simulation tool was tailored to the specific needs of the multifamily market and other program considerations and collaboration were designed into the next evolution of the program. These recommendations are outlined below.

Energy Savings Target

The target of 20% improvement in building energy efficiency required for participation in the Designed for Comfort program is appropriate today, in 2008. This target is realistic for most rehab projects, yet still challenging. While each project varies immensely from the next, many existing multifamily building, when improved by 20%, come close to meeting Title 24 requirements for new construction. As energy efficient building systems and technologies progress, building renovation and new construction standards become more stringent, and societal pressures push more building owners to upgrade energy efficiency measures, the improvement margin required to qualify for rehab incentive programs should also grow.

More Comprehensive Approach

Though the Designed for Comfort program addresses many building services systems, including space heating, space cooling, domestic hot water, and the building envelope, there are many more avenues for increasing energy efficiency in multifamily residential buildings. For example, a more comprehensive program would also consider lighting improvements, efficient appliances, and building diagnostic testing in the calculation. Taking that thought further, water-saving features, such as sink aerators and low-flow showerheads, might be incorporated into a more inclusive program. These items reduce the need to heat water and also lessen demand on water pumps, thus saving additional energy. Perhaps the Energy Star program could also be incorporated into a utility program for rehabilitation projects.

Typically, utility incentive programs are specific to occupancy (e.g. residential or commercial), leaving pieces of multifamily and multiuse projects looking elsewhere for funding and assistance. The Designed for Comfort program, for example, only offers incentives for improvements made to dwelling units. A more comprehensive program would additionally offer incentives and assistance for the apartment's management office, recreation room, laundry room, and other common areas. In multiuse projects, incentives available for residential and commercial spaces, under the umbrella of a single program, would encourage owners to take a step further in energy efficiency without overwhelming the owner or developer with a myriad of programs, qualifications, and paperwork.

Further Education

Energy education for the occupants is a complementary element of a comprehensive weatherization program and of the Designed for Comfort Program. This energy education instructs people in the proper operation and maintenance of new or existing energy systems so that the full potential of these systems is realized. Topics frequently covered in energy education include filter changing, thermostat operation, strategies to reduce cooling load such as closing window shares, and use of the ventilation systems.

It is a well-known fact that people use energy, not buildings. Even a well-designed building, if not used properly, can operate inefficiently. Programs that educate the operations and maintenance staff, the owner, and the tenant have better chances at reaching and exceeding the estimated energy savings mark set for a particular building or project.

A good start is to include a handbook with specific information on how to operate and maintain installed systems following a building rehabilitation. A more thorough approach would include a walk through and demonstration of the building upgrades. Hosting a tenant training is good way to spread the word about recent building improvements and how to save energy on an everyday basis to the complex residents. Including information on the California Alternate Rate for Energy CARE, Family Electric Rate Assistance program, and other financial assistance programs available to affordable housing tenants can increase interest and attendance to such events. At a minimum, a brochure or handout distributed to tenants will increase awareness of efforts to increase energy efficiency in their complex and community.

Better Tools

Streamlining the program process, inspections, and energy analysis is a constant battle with rehabilitation programs. Through implementing the Designed for Comfort Program, we have found that when the HERS rater also acted as the energy consultant, the audit, analysis, and final inspection steps happened more smoothly and in a shorter timeframe. Over time, professionals that were either a HERS rater, or an energy consultant, but not both, have been excluded from program participation because building owners are looking for a one-stop-shop that can take them through the program from start to finish.

Development of tools and trainings, such as the CHEERS RateTool and Existing Homes Rating System training, will help immensely in this area, allowing the HERS rater to perform the energy audit and also act as energy consultant. A HERS Rater equipped with knowledge of energy simulation software can conduct the building energy audit and analysis more efficiently than if the audit and analysis were performed by separate parties.

In addition to the energy simulation capabilities of software approved for Title 24 compliance calculations, RateTool allows for a more comprehensive analysis, adding appliances, lighting, and building diagnostic testing as factors in the energy simulation model. As an EnergyPro tool, RateTool has additional features to calculate the estimated upgrade cost and utility cost savings associated with specific energy efficiency measure upgrades, and provides a score that ranks the a home among its peers, both with and without the recommended upgrades. RateTool establishes a baseline (existing) and calculates energy and cost savings associated with multiple upgrades in a single simulation run. It allows the building owner and HERS Rater to compare energy upgrade options side by side in an easy-to-understand output.

A number of software tools are available continually updated in response to demand for baseline and existing home modeling and rating. TREAT software, originally designed to assist weatherization programs in building energy analysis is similar to RateTool, in that it establishes a baseline based on existing conditions and allows the user to input recommended building upgrades to estimate the cost benefits and energy savings. With the addition of HVAC modeling, this tool is following the trend towards more comprehensive modeling.

eQuest aims to provide a quick modeling tool for members of the building design team. Though the program is flexible and allows the user to decide how much detail to enter, input is similar to a computer aided drafting program and thus requires familiarity with architectural plans, so is less practical for many energy consultants. As HERS raters and energy consultants become more acquainted with these various simulation programs, and as the software evolves, programs like the Designed for Comfort program may be able to allow alternatives to EnergyPro for program qualification.

Financing Options

Utility incentive payment structures commonly cause struggle, especially for affordable housing owners. Because the incentive funds are paid upon project completion, the owner often has difficulty with the upfront costs of the building rehab. Financing built into utility bills is a potential solution to this problem for some building owners, allowing the owner to pay for the upgrade measure over time.

Moving Forward

Based on the experience of implementing this program throughout the state of California, the lessons learned, applying the program to all existing multifamily buildings, collaborating with existing utility programs, and addressing AB 549 residential strategies, we make the following recommendations

Develop a program that will:

- Provide performance-based incentives to the building owner
- Streamline the process of audit, analysis, and inspection by creating a sub-category of the energy consultant and HERS Rater industries by combining their efforts into one service that the multifamily owners can “one stop shop” for these services.
- Because there is a bit of a learning curve, offer incentives to this energy consultant/HERS Rater service provider until the industry can stand on its own
- Offer incentives for both market rate and affordable housing, with higher incentives to affordable housing, similar to the strategy of the New Solar Homes Program that offers a higher incentive to affordable housing developers than it does to market rate developers.
- Provide a truly comprehensive program that incorporates not only heating, cooling, and water heating but also, lighting and appliances (in dwelling units and common areas), common areas

- Provide utility "On-Bill Financing" option for property owners to avoid lost opportunities whereby owners cannot participate in the program due to lack of up-front funds. Because any rate-payer funded program is not set to cover the full cost of the upgrades, the building owner must seek other funding through existing reserves, grants, tax credit funding, or financing. Utility financing is an option for owners to choose from when coordinating their financing package and is convenient as it is included in the monthly energy bills.
- Collaborate with other energy efficiency and green building programs through combined marketing efforts and approval processes
- Develop a new, or tailor an existing, building simulation tool specific to the nature of multifamily buildings and their common areas that comprehensively analyzes all measures and their interactions
- Provide operations and maintenance training to multifamily building owners and maintenance staff to increase the longevity of optimal performance of equipment and measures
- Provide information to tenants and homeowners to properly use replaced measures as well as to provide information on energy saving tips, CARE rates, and other utility programs
- Continue to work with HUD, the housing authorities, and CEC on the development of the Project Specific Utility Allowance tool to develop an accepted EEBUA for existing buildings.

References

[CEC] California Energy Commission. 2005. Options for Energy Efficiency in Existing Buildings. Sacramento, California.: California Energy Commission