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**Infrared
Thermography**
*What Works and
What Doesn't*

**Do CFLs Still
Pass the Test?**

ECM Efficiency
*Better (and Worse)
Than You Think*

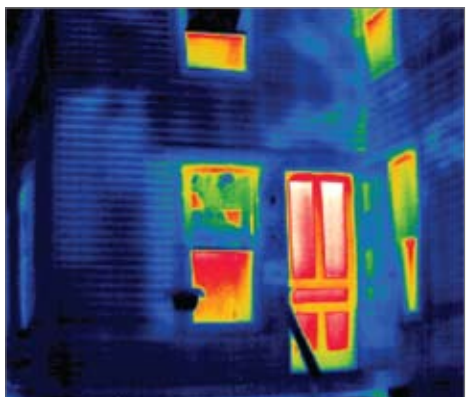


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Multifamily Housing

The Overlooked Sector for Energy Efficiency

BY NEHEMIAH STONE

Over 30% of the U.S. population and over 25% of U.S. households live in multifamily (MF) buildings. Yet when we talk about possible energy efficiency improvements in the residential sector, we seldom think of opportunities outside of single-family (SF) homes, and we almost never consider technologies that are appropriate only for MF homes. In fact, almost every study of the potential for energy efficiency in the existing residential sector either excludes MF buildings or includes them as a nonspecific part of the aggregate residential sector. *U.S. Multifamily Energy Efficiency Potential by 2020*, a report prepared by the Benningfield Group, is meant to help national and regional policymakers understand achievable energy efficiency potential in the country's existing MF sector. The report is the most comprehensive survey of potential energy efficiency savings in the multifamily/apartment market conducted to date. It provides a clear and compelling case for scaling up energy efficiency retrofit activity for the 26 million apartments located in the United States, including those that are home to some nine million families below the poverty level, and four million elderly households. (See Figure 1).

The report analyzes energy savings potentials by geographic region and household type, and describes the unique characteristics of MF buildings that policymakers need to consider when contemplating how to achieve these efficiency potentials.

THE CASE FOR A MULTIFAMILY STUDY

The reasons for increasing energy efficiency spending on MF buildings are not primarily technological. The reason this report focuses on MF is that almost no studies have focused on MF in the past. This means that, as the authors of the report discovered, there is a lot of low-hanging fruit to harvest, based on what we now know about the prevalence of MF housing in the United States, and about the opportunities this housing provides to save enormous amounts of energy and money.

California, for example, has had building standards since 1978, and these standards have been updated every three years

on average. Though the cycles have not been consistently timed, we are now on the ninth iteration of the standards, with changes specific to SF homes made in every cycle. But it was only in 2001 that the California Energy Commission began to consider whether the models for SF homes, on which the residential standards are based, even made sense for MF. No major changes took place until the 2005 Building Energy Efficiency Standards (Title 24, Part 6) took effect. Prior to that, the fact that MF buildings normally have about half the window area of SF homes (as a percentage of floor area) meant that they got a false energy efficiency "credit" when showing compliance using building performance software. Consequently, the designers of MF buildings were lulled into thinking that their buildings were efficient, with very little incentive to think at all about how efficient they could make them until the 2005 standards took effect. (Starting in 2005, the building performance software quit giving "credit" for having less than 20% window area. MF homes generally have 8%–10%, while SF homes generally have over 20%.)

Here's another example of how we have ignored opportunities to make MF buildings as efficient relatively, as SF homes. The first SF new-construction programs were launched around 1980, but the first utility-sponsored MF new-construction program wasn't launched until 1999. And although over the past ten years, the MF programs have helped increase focus on MF energy efficiency, they did not push the MF industry nearly as hard as the programs focused on SF homes pushed that industry. In fact, as late as 2004, while the window area anomaly still existed, along with a similar anomaly in central hot water systems, some developers were building MF projects with less insulation and less efficient windows than allowed by California's prescriptive-compliance path, and were still qualifying for the utilities' incentive money.

Another reason this report is so important is an economic one: 80% of low-income families live in MF, and 80% of households who live in MF are low income. There is a distinct correlation between income level and MF living. Families in affordable housing

spend an average of 20% of their monthly income on utilities—compared to under 5% for the average of all households. And these families, to whom efficiency would mean so much more, have almost no opportunity to improve their energy use picture. They can't insulate or replace HVAC or domestic hot water (DHW) equipment. Conversely, there is generally too little return on the investment in insulation and efficient equipment for the property owner (or landlord) to care. Property owners consider MF a business. They can't be expected to make investments without a reasonable rate of return. The bottom line is that the people who most need to have energy efficiency upgrades can least afford them, and wouldn't be in a position to fund them anyway because they don't own the property.

THE TECHNICAL PART

So the primary reasons for focusing on MF are (1) the size of the previously ignored opportunities that it provides, and (2) tenant economics. But there is also a technical reason. MF buildings provide some unique opportunities to include efficient technologies. A classic example is the central domestic hot water (CDHW) system common in MF buildings. About 40% of MF units in California are served by a CDHW system (versus individual water heaters). These systems send hot water from a boiler or water heater out in a loop from which branch lines serve individual apartments. The loop has a pump on the return line drawing unused hot water back to the storage tank. In most existing MF buildings, the pump runs 24 hours a day, seven days a week, 52 weeks a year, and the pipes in the circulation loop are not generally insulated. (California's building standards now require that all the piping in circulation loops in new construction be insulated, but there is no requirement to insulate the estimated 4,000 miles of uninsulated pipes in California's existing MF buildings.)

Before the 1990s in Los Angeles, it was common to install the boiler in a courtyard outside and to run bare (uninsulated) copper pipes underground to the apartment buildings. Considering that the average ground temperature is around 55°F, and the water leaving the storage tank has to be above 140°F in order to be hot enough to serve tenants' needs once it gets to them, these systems represent an incredible waste of energy. If there were no circulation pump keeping the water near the apartments hot, the amount of water wasted while tenants waited for the hot water to

reach them would represent an even larger waste of resources. MF building owners have traditionally addressed this second problem by having the circulation pump run all the time. They will do whatever it takes to keep tenants from complaining.

A 2008 study of 139 CDHW systems that had received temperature modulation controls as part of Southern California Gas Company's and San Diego Gas & Electric Company's MF rebate programs found that most systems were set above 130°F, with more than a dozen set at 140°F and some at 160°F. Temperature modulation controls change the setpoint of the water-heating system over the course of a day, so that the water in the storage tank is always hot enough to meet the amount of hot water demanded. Two hundred gallons of 140°F water can serve a lot more showers than 200 gallons of 110°F water, but when 110°F water is sufficient, there is no need to deliver hotter water.

The hotter the water in the

circulation loop, the greater the heat losses to the environment. It takes ten seconds at 125°F for a child to get a second-degree burn. At 140°F, it takes two seconds. At 160°F, it takes less than two seconds to get a third-degree burn, and a second-degree burn is almost instantaneous. Although only about one-third of households are in MF buildings, 54% of children suffering hot water burns are in MF (from the factsheet, "Hot Tap Water and Scald Burns"—see "For more information" below). Still, the most common action that building maintenance staff take when tenants complain of not having enough hot water is to turn the setpoint up until the complaints stop.

There are two ways to help ensure that hot water is available when needed, without wasting so much energy. The first is to install a temperature modulation control. The second is to install a demand control.

A temperature modulation control lets the pump continue to run all the time but resets the water temperature down when the demand is low, and up again when demand is high. The 2008 KEMA study found that, compared to systems where the setpoint is constantly at the high temperature needed to meet peak hot water demand, the temperature modulation control saves about 400 therms per system per year on average. This represents a savings of about \$5,000 over ten years at recent California natural gas prices.

Multifamily to Single-Family Ratio

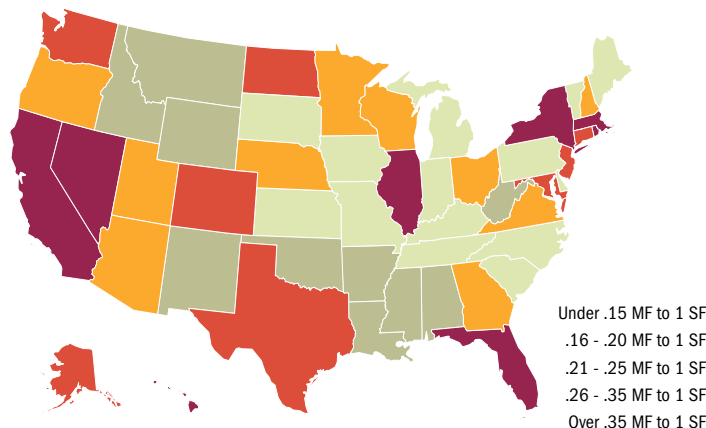


Figure 1. There are 26 million apartments located in the United States, including those that are home to some nine million families below the poverty level, and four million elderly households.

Ironically, MF is inherently more energy efficient than SF in many ways, but the energy-saving opportunities that MF provides have not been met.

A demand control shuts the pump off when it isn't needed. There are two times when the pump isn't needed—when no one is using hot water, and when someone is using hot water. The only time the pump really needs to run is when there is a draw after a long enough period of no draws that the water in the pipes has lost its useful heat. When people are using hot water, their draws keep the water in the loop hot, so the pump does not need to run. Among 35 monitored sites with demand controls, the pumps ran an average of 1.8 hours per day, instead of 24 hours per day. The gas savings averaged a little over 1,500 therms per year, and the electricity savings averaged about 1,200 kWh per year. It costs about \$3,000 start-to-finish to install a demand control. At \$1.10/therm for gas and \$0.09/kWh for electricity, payback is about 1.7 years. Central hot water is not the only technology that offers unique energy savings in MF buildings, but it is often the most cost effective.

POLICY PERSPECTIVE

The historic lack of attention to MF buildings is troubling from a policy perspective, for two reasons. First, improving the energy efficiency of MF housing requires a different approach than improving the energy efficiency of SF housing (as shown by the hot water example above). Second, the tenants of MF buildings have generally lower incomes than residents of SF housing, as explained above, and they spend a much higher percentage of their monthly income on utilities.

Ironically, MF is inherently more energy efficient than SF in many ways, but the energy-saving opportunities that MF provides have not been met. Policymakers looking to garner savings in MF need to recognize that, given the geometry of MF buildings, less of the savings will come from improving the efficiency of the building envelope and the HVAC system, and more will come from improving the efficiency of the water-heating system and the appliances. They also need to recognize that MF provides significant opportunities for bundling energy uses to realize an economy of scale when making efficiency improvements. One example would be installing central hot water systems instead of a myriad of individual water heaters. Also, national Residential Energy Consumption Survey data show that, although MF units have a somewhat higher energy use per square foot (measured in kBtu/ft²), they have a significantly lower energy use per household or per capita. Households in buildings with over five apartments use only about 40% as much energy as those in SF detached housing.

The Center for Neighborhood Technology in Chicago, Illinois, has created an online tool for making comparisons of the costs

of housing and transportation for owners and renters in various regions of the country. The tool also allows one to view the Green House Gas (GHG) intensity for locations within the selected region. Although the thrust of the Benningfield Group report concerns improving the efficiency of MF buildings in the nation's housing stock, building energy use is just part of the overall picture. Because they are predominantly in urban settings, MF households use significantly less energy for transportation as well. One way in which this is made clear is through a comparison of urban and rural CO₂ emissions from transportation.

Another difference with energy policy implications is the fact that most large appliances in MF buildings are the property of the building owner, not the renter, though it is the renter who pays the energy bills. Since the owner generally has no economic motivation for upgrading them, these appliances tend to be older and less efficient than those in SF homes. The irony is that renters pay a higher share of their monthly income for utilities, yet they are less able than homeowners to improve the efficiency of their homes.

Approximately 86% of all SF homes are owner occupied, while 88% of MF homes are occupied by tenants, and tenant household income is roughly half that of the average owner household (approximately \$31,000 per year versus \$61,000 per year). So even when tenants do own their refrigerators, washers, and dryers, the appliances are more likely to be older and less efficient. This means that there is a greater unmet need for appliance upgrades among MF households than among SF households. Because tenants make less money than owners (and spend more of their limited income on utility bills), their appliances will not be upgraded without a higher level of public or utility funding than is needed for the SF market.

POTENTIAL SAVINGS

The Benningfield Group report recommends that the United States invest approximately \$8 billion in energy efficiency improvements in the nation's MF housing stock over the next eleven years. If the report's recommendation is adopted, the anticipated savings will be:

- The United States could achieve energy savings equal to the annual electrical output of 20 coal power plants and the entire non-power plant natural gas usage of California, Oregon, and Washington combined. The report conservatively estimates a cost-effective energy savings potential of approximately 30% in MF residential buildings.
- Making efficiency retrofits to existing MF buildings will reduce CO₂ emissions by 50 million to over 100 million tons per year. This is equivalent to the emissions associated with

the entire current energy usage of four million to eight million U.S. households.

- Retrofitting existing MF buildings near transit is a win-win. Energy-efficient retrofits reduce energy use in the housing, and the residents' use of mass transit reduces energy use in transportation. Between year and year, the report observes that renters' utility costs—in real dollars—increased more than twice as fast as the cost of their rent over the same period.
- The report observes that tenants and owners could reap a \$9 billion annual energy dividend from cost-effective investment in energy retrofits of MF housing in the United States. This dividend would have a proportionately higher value to low-in-

come renters, for reasons explained elsewhere in this article. MF properties pose unique barriers to “naturally occurring” energy efficiency upgrades. Tenants generally pay the utility bills and reap the savings from any energy efficiency investment that the owner might make. Owners therefore, have little incentive to invest. This split-incentive problem in MF housing could be addressed by having utilities focus much more of their energy efficiency spending on MF properties. If the United States spent \$100 million to \$200 million of the almost \$2 billion of annual demand side management (DSM) funds, that would be just commensurate with the share of energy used in MF buildings. Since the MF sector has often been underserved in the past, even more spending could be justified. HUD, owners of MF buildings, and other stakeholders should work with local utilities to bring this level of funding to MF properties so that as many as 100,000 units per year could benefit from efficiency upgrades.

>> For more information:

U.S. Multifamily Energy Efficiency Potential by 2020. Folsom, CA. Benningfield Group, Incorporated, October 2009. For a copy of this report go to www.benningfieldgroup.com.

Multifamily Boiler Controls – Process Evaluation: SoCal Gas' and SDG&E's 2006-08 Multifamily Energy Efficiency Rebate Program. KEMA.

To read the factsheet, Hot Tap Water and Scald Burns, go to: www.safekid.org/. For more info on the National Residential Energy Consumption Survey data go to the Energy Information Administration's Independent Statistics and Analysis at www.eia.doe.gov/emeu/recs.

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