ACEEE Topic Brief
American Council for an Energy-Efficient Economy

Understanding Multifamily Home Energy Efficiency Potential

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Increased Focus on Multifamily Energy Efficiency

Multifamily buildings, those with five or more apartments or condominiums, have historically been underserved by government and utility energy efficiency initiatives. However, policymakers and program administrators have been increasingly focusing on these properties in recent years. Between 2011 and 2015, utility spending on multifamily energy efficiency retrofit programs nearly tripled.[1] Several state and local governments are also now pursuing policies and programs that prompt multifamily owners and managers to analyze, share, and improve their properties' energy use.[2]

Nationally, multifamily homes with high energy bills can use energy efficiency upgrades to reduce their consumption by 17%, saving $3 billion in energy costs.

While these initiatives can take different forms, they commonly make efficiency improvements to multifamily properties' building envelopes, space and water heating systems, air conditioning equipment, lighting, and major appliances. We estimate that making these improvements to the apartments and condominiums that fall in the top 25% of multifamily energy users has the potential to reduce multifamily residential energy use across the United States by approximately 17% and save residents $3 billion in energy costs.

This topic brief focuses on the energy that could be saved by making efficiency improvements to residential units in multifamily properties. Although our analysis does not include the common areas (e.g., lobbies, community rooms, recreation areas, hallways) usually found in multifamily properties, some comprehensive multifamily retrofit programs do improve the efficiency of the entire building, and several have achieved whole-building energy savings greater than 20%. The U.S. Department of Housing and Urban Development's Green Retrofit Program has reported whole-building energy savings of up to 24%.[3] The New York State Energy Research and Development Authority Multifamily Performance Program has achieved similar energy savings of up to 22% in multifamily buildings.[4] California's Low-Income Weatherization Program for Multifamily Properties has reported whole-building energy savings of up to 38%.[5]

Calculating Multifamily Savings

We calculated our residential multifamily energy and cost savings estimates using data from the U.S. Energy Information Administration's (EIA's) 2015 Residential Energy Consumption Survey.[6] EIA periodically surveys homeowners and renters regarding their energy use and uses this information to model both total home energy use and energy use by end use. Using this survey and modelled data, we first normalized each multifamily household's end use energy consumption by total home square footage, number of residents, or annual appliance uses.[7] We also normalized space heating and air conditioning energy use by heating degree days and cooling degree days, respectively. We then identified the top 25% of energy users for each end use and calculated the electricity and natural gas savings that could be achieved by reducing these households' energy use to that of the median multifamily household.[8] We calculated cost savings by multiplying the potential savings for each end use by national average 2015 electricity and natural gas residential rates.[9,10]

Energy Savings Potential by End Use

Figure 1 identifies the share of total multifamily energy savings that each residential end use could provide. As of 2015, space and water heating systems had the potential to produce nearly two-thirds of total multifamily residential energy savings.[11] Each of these end uses accounted for just over 30% of potential multifamily energy savings, with slightly more potential energy savings in natural gas systems than electric systems. Lighting accounted for one-fifth of possible multifamily energy savings, while air conditioning accounted for one-tenth of savings. The remaining savings, totaling roughly 6%, could be achieved through upgrading major household appliances.

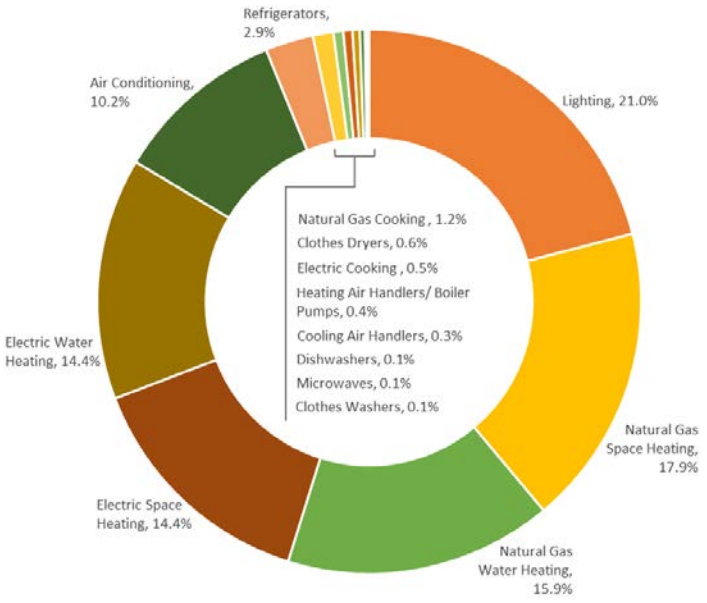

Figure 1. Shares of multifamily energy savings attributable to different end uses.

Regional Opportunities

As figure 2 shows, multifamily residents in southern states were more likely than those in other regions to use large amounts of electricity for space heating, air conditioning, water heating, and lighting. In contrast, multifamily households in the Northeast were more likely than those in other regions to be high users of natural gas for space and water heating. However, northeastern homes were about as likely as those in the South to be high users of electricity for air conditioning. While less likely to have high energy users than other regions, the Midwest and West still hold substantial multifamily energy savings potential. More than one in five multifamily households in both regions are high users of electricity for lighting. Roughly 20% of Midwest multifamily homes use a large amount of energy for air conditioning and natural gas water heating.

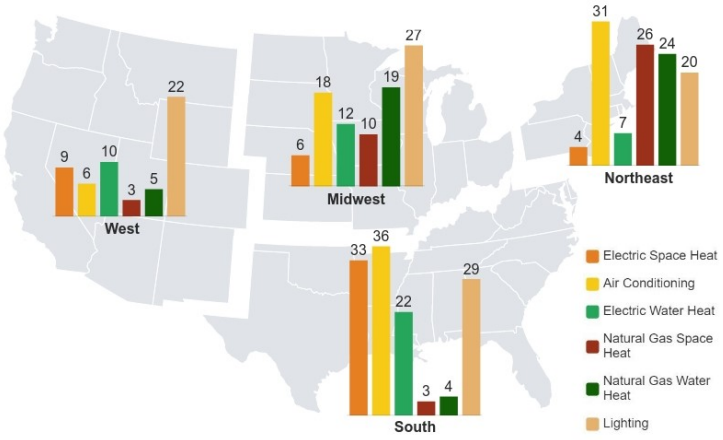

Figure 2. Regional percentage shares of multifamily homes with high energy users by end use.

Reducing Energy Burdens for Low-Income, Non-White, and Hispanic Residents

Low-income multifamily, non-white, and Hispanic households experience high energy burdens, using a large share of their income to pay for energy bills. Nearly half of low-income multifamily households experience an energy burden greater than 6%.[12] More than one-third of Black and Native American households and nearly a third of Hispanic households have energy burdens higher than 6%.[13] Our research reveals that electric end uses are the leading cause of high energy consumption for low-income, non-white, and Hispanic multifamily households, followed closely by natural gas space and

water heating.[14] Table 1 shows the most common high energy end uses that contribute to these groups' energy burdens.

Table 1. Most common high energy end uses contributing to low-income, non-white, and Hispanic multifamily household energy burdens

Low-income	Non-white	Hispanic
Electric water heating (30%)	Electric water heating (30%)	Electric space heating (37%)
Air conditioning (26%)	Air conditioning (26%)	Air conditioning (35%)
Electric space heating (26%)	Lighting (24%)	
Lighting (24%)		

Here we show the highest energy end uses for each group that also have the smallest 95% confidence interval. The percent values shown alongside each end use reflect the shares of each group that are considered high energy consumers for that end use. Those that do not have or use the equipment associated with a given end use have been excluded in calculating those values. While the range of uncertainty associated with our 95% confidence intervals varies for each end use, the share of a group that consumes large amounts of energy for any one end use listed here is never lower than 17%. While natural gas water heating met these criteria for low-income households (27% of those with natural gas water heating are high energy users), we excluded it because our data indicate a substantial share of these households do not pay for this energy use.

Air conditioning (AC) is a high-consumption end use for all three groups, and EIA projections indicate that AC energy use will increase at a faster pace than any other end use between now and 2050.[15] For multifamily residents with central AC systems, high energy consumption is twice as likely among those with systems that are at least 10 years old compared to those with newer systems, indicating a possible need for system retuning or replacement. Weatherization improvements may be needed to reduce energy use for multifamily households with window AC units, as roughly five in six of the highest energy users live in buildings constructed before 1980, prior to the advent of state building energy code standards. These properties are also more likely to need repairs and maintenance.

In multifamily buildings, electric water heating is a source of high energy use for a substantial number of low-income and non-white households. Electric space heating is responsible for high energy use in many low-income and Hispanic homes. Roughly three-quarters of multifamily households with high water-heating electricity use have a water heater in their apartment and pay for their own electricity. Four in five multifamily households with high electric space heating energy use also pay for their own utilities. Landlords may be hesitant to invest in energy efficiency improvements for these systems, as they will not see a direct financial benefit from such upgrades.

Lighting is a high energy end use for low-income and non-white households. Three in four high lighting-energy users in multifamily housing reported that at least half of the light bulbs in their homes were inefficient incandescent bulbs. Lighting upgrades are one of only a few energy efficiency improvements that multifamily residents can make without first asking for property owner or management permission, but recent research indicates that these households may have limited opportunities to purchase affordable energy-efficient light bulbs. Large retail stores provide the greatest availability and lowest cost for energy-efficient compact fluorescent lamps (CFLs) and light-emitting diode (LED) light bulbs.[16] However, multiple studies have found that these stores are less frequently located in neighborhoods where a majority of residents are low-income or Black.[17,18,19]

The Path Ahead

While many cities and states have increased their focus on improving multifamily energy efficiency, ample energy-saving opportunities remain. ACEEE's Multifamily Energy Savings Project focuses on

supporting efforts by policymakers and program administrators to create or expand multifamily energy efficiency initiatives. For more information on our research and technical assistance opportunities, please contact Stefen Samarripas at ssamarripas@aceee.org.

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[1] Samarripas, S., D. York, and L. Ross. 2017. *More Savings for More Residents: Progress in Multifamily Housing Energy Efficiency*. Washington, DC: ACEEE. aceee.org/research-report/u1702.
[2] ACEEE (American Council for an Energy-Efficient Economy). 2020. "State and Local Policy Database." Accessed July. database.aceee.org.
[3] Braman, J., Kolberg, S., and J. Perlman. 2014. *Energy and Water Savings in Multifamily Retrofits*. New York City: Bright Power. brightpower.com/wp-content/uploads/2016/09/Energy-and-Water-Savings-in-Multifamily-Retrofits.pdf.
[4] Yancey, R., E. Abramowitz, A. Hinge, J. Perlman, C. Laver, and Y. Frank. 2015. *Retrofitting Affordability*. New York City: Building Energy Exchange. be-exchange.org/report/retrofitting-affordability/.
[5] Samarripas, S., and D. York. 2019. *Closing the Gap in Energy Efficiency Programs for Affordable Multifamily Housing*. Washington, DC: ACEEE. aceee.org/research-report/u1903.
[6] EIA (Energy Information Administration). 2018. "2015 RECS Survey Data." Accessed April 2020. eia.gov/consumption/residential/data/2015/index.php?view=microdata.
[7] We normalized space heating, air conditioning, and lighting by total square footage. Water heating was normalized by number of people in a household, and major appliance energy use was normalized by number of annual uses. We excluded consideration of plug loads associated with devices not generally categorized as major household appliances, as these are not typically considered in policies and programs designed to improve multifamily energy efficiency. While we do not include these plug loads in our final analysis, these loads are substantial. Using the methodology outlined here, we estimate that reducing the energy consumption of the top 25% of plug load households to that of the median household would reduce total multifamily energy use by 5.7% and save approximately $1.5 billion in energy bills.
[8] RECS survey data responses are likely to contain some errors, and modelled outputs have an unknown degree of uncertainty. We chose to focus on the difference in energy use between the top 25% of households and the median rather than the top 50% and the median because it reduces the likelihood of errors in our estimates. However, this may mean our estimate is comparatively conservative.
[9] EIA (Energy Information Administration). 2020. "Electricity." Accessed July. eia.gov/electricity/data.php.
[10] EIA (Energy Information Administration). 2020. "Natural Gas." Accessed July. eia.gov/naturalgas/data.php.
[11] Data used for our analysis cannot be used to determine the degree to which space heating and cooling energy savings originate from efficiency improvements to a building envelope versus its equipment.
[12] ACEEE's 2020 energy burden research defined low-income households as those earning at or below 200% of the federal poverty level.
[13] Drehobl, A., L. Ross, and R. Ayala. 2020. *How High Are Household Energy Burdens? An Assessment of National and Metropolitan Energy Burden across the United States*. Washington, DC: ACEEE. aceee.org/research-report/u2006.
[14] For the purposes of our analysis here, low-income multifamily households are those earning less than $40,000 per year.
[15] Energy Information Administration. 2020. "EIA Projects Air-Conditioning Energy Use to Grow Faster than any Other Use in Buildings." Accessed September. https://www.eia.gov/todayinenergy/detail.php?id=43155.
[16] Reames, T., M. Reiner, and M. Stacey. 2018. "An Incandescent Truth: Disparities in Energy-Efficient Lighting Availability and Prices in an Urban US County." *Applied Energy* 218: 95–103. justurbanenergy.files.wordpress.com/2018/03/reames-reiner-stacey-2018-an-incandescent-truth-w-supp.pdf.
[17] Ibid.
[18] Small, M. and M. McDermott. 2006. "The Presence of Organizational Resources in Poor Urban Neighborhoods: An Analysis of Average and Contextual Effects." *Social Forces* 84(3): 1697–1724. scholar.harvard.edu/files/mariosmall/files/small_mcdermott_sf_2006.pdf.
[19] Bellinger, W. and J. Wang. 2011. "Poverty, Place or Race: Causes of the Retail Gap in Smaller US Cities." *The Review of Black Political Economy* 38: 253–270. econweb.ucsd.edu/~juw046/pdfs/RBPE.pdf.