Resident Energy Experiences in a Low-Income Multifamily Community (Detroit, MI): A Study of Energy Consumption, Health, and Quality of Life

Madeline W. Miller, University of Michigan School for Environment and Sustainability
Kaan Cem Ketenci, University of Michigan Department of Environmental Health Sciences

ABSTRACT

Residents living in low-income multifamily housing face ongoing challenges related to energy affordability. These challenges may impact their health, comfort, safety, and quality of life. High energy bills are an indicator that a home's envelope and/or its systems are inefficient. Utility and federally-based energy efficiency (EE) programs typically serve single-family residents, while multifamily residents have similar needs that are often more complex to meet. Most existing programs for multifamily residents provide foundational upgrades (i.e., LED light bulbs, faucet aerators, hot water pipe wrapping), but do not provide large appliance upgrades or recommend ways to improve a home's envelope. This paper describes methods used to assist in the successful deployment of basic EE upgrades to a low-income multifamily community, followed by the implementation of a scoring procedure that recommends ways to improve the efficiency of each home in a cost-effective manner. The scoring procedure will be used to generate a baseline R-value recommendation for the application of insulation and suggest other improvements needed to retrofit multifamily units built several decades ago. This research recommends best practices for implementing energy efficiency programs in the multifamily sector and makes a case for the application of comprehensive energy-efficient upgrades in similar housing.

Introduction

Public housing properties consisting of dated multifamily units exist across the United States. Residents of these units typically rent as is and lack decision-making power when it comes to appliances and heating and cooling systems in their homes. The inefficiency of these systems is largely responsible for the bulk of the costs of energy, much of which is wasted, in many multifamily homes. For residents operating on fixed incomes or who have extremely low earnings, high energy expenses inhibit their ability to access other necessities, such as food and medicine. These difficult tradeoffs persist for as long as multifamily dwellings go without comprehensive energy upgrades. Basic energy-conserving measures like LED light bulbs provide minimal savings and are not truly effective in homes that need new HVAC systems, efficient appliances, updated building insulation, and securely sealed windows and doors as deep retrofits. Property owners and managers are often not motivated to make these improvements without incentives. As long as owners and managers can pass the high energy costs to tenants, they can be profitable while providing the bare minimum to residents. Building owners and managers need substantial financial assistance as well as technical support to make these homes energy-efficient. Residents with low income are generally eligible for direct install measures, including LED light bulbs, faucet aerators, low-flow shower heads, Wi-Fi-enabled thermostats, and other small appliances through local utility programs. These residents, however, lack the decision-making power and financial capacity to make deeper retrofits to their units that might lower energy costs, increase comfort, and make their homes safer and more aesthetically pleasing among other benefits.

Utility-offered energy efficiency programs, where basic energy conserving measures are provided to residents with low income at no cost, offer a pathway to a deeper knowledge of energy concepts and increase the likelihood that residents will pursue deeper retrofits. Deep retrofits include multiple energy efficiency measures that often upgrade heating, cooling, ventilation, and other systems (Srivastava 2022). Once energy and cost savings from small measures are assessed, it is not uncommon for program participants to seek out ways to gain additional savings. Financing deep retrofits is arguably the biggest challenge in securing and implementing systems that will yield the greatest savings. For public housing residents operating within traditional leasing terms, additional energy-saving measures applied to their units create a split incentive scenario, where the property owner or manager pays for the improvements, but the tenant receives the actual benefits (i.e., monetary savings and increased comfort) of the upgrades. Thus, securing outside funding sources for these improvements makes them more likely to happen. For residents who have exhausted all free energy efficiency resources like those at the center of this study, organic partnerships in which special accommodations are made for residents offer the next best option.

This study is focused on a low-income multifamily community located on the east side of the city of Detroit, the Villages at Parkside. This public housing community was originally constructed in the 1930s as Detroit's first funded public housing project and has not been rehabilitated for many years. The Detroit Housing Commission (DHC) and other private firms have assumed ownership and management of the Villages at Parkside, and in recent years, plans to demolish existing buildings on the property as part of a more robust redevelopment effort have been announced. While each U.S.-based public housing community has a unique history, residents in the Villages at Parkside have similar housing-related burdens to residents with low incomes living in similar federally subsidized structures across the country. In many of these communities, there are no plans for redevelopment, even though living conditions can be worse and energy burdens can be much greater. This study utilizes data from an energy efficiency intervention carried out in the Villages at Parkside in collaboration with University of Michigan (U of M) researchers and Friends of Parkside, a community-based 501(c)(3) located in the Villages at Parkside.

In Phase 1 of this research, basic energy conserving measures (ECMs) and ENERGY STAR refrigerators were deployed to homes in the Villages at Parkside, followed by an energy consumption analysis to help researchers understand the cost and monetary savings of these upgrades. This phase of the research, Phase 2, utilizes the United States Department of Energy (DOE) Home Energy Score system to evaluate units and understand what, if any, measures need to be performed to achieve greater energy efficiency. Qualitative and quantitative findings from DOE Home Energy Scores performed by certified Home Energy Score Assessors indicate improvements needed to the units, as well as any other recommendations to be considered as the local housing commission embarks on the redevelopment of this property. The DOE Home Energy Score uses a one-to-ten scale to rate the efficiency of a home, where one represents the least efficient home and ten represents the most efficient home. The tool estimates the as-is energy use and costs and makes recommendations for improving the efficiency of a home and lessening its associated energy costs (U.S. Department of Energy 2022). A total of 10 homes on this property were scored. The resulting scores will be used to generate recommendations for cost-effectively improving each unit as residents await formal redevelopment.

Methodology

During Phase 1 of this study, residents of the Villages of Parkside were recruited to participate in an energy efficiency study. U of M researchers contacted Walker-Miller Energy Services, a local energy waste reduction company and contractor for the local utility. The local utility has been running a ratepayer-funded utility-sponsored energy efficiency program which includes basic upgrades at no charge since about 2009. The U of M team coordinated several meetings between leadership from the Villages at Parkside, Friends of Parkside, and Walker-Miller Energy Services to ensure that the property and its residents were eligible for these upgrades, and to ensure that upgrades and schedules were approved by building management. The research team worked with the Friends of Parkside leadership team to coordinate kickoff meetings between the study team and residents to provide team introductions, share basic information about the utility-offered program, and prepare residents for upcoming home visits. The upgrade offerings include energy conservation measures (ECMs) such as LED light bulbs, Wi-Fi-enabled thermostats, bathroom and kitchen sink faucet aerators, and stainless-steel ENERGY STAR refrigerators. At this point in the study, some participants had already received home visits and upgrades, as all residents on the property were eligible. Personnel from Walker-Miller Energy Services attended these meetings to answer program-related and other questions from residents.

During these workshops, the study team and technicians made presentations to help residents understand the project and distributed surveys to collect energy, appliance, household, and health information from participants. The team also collected utility bills to help researchers identify trends in household energy consumption. Finally, participants were given temperature monitors to place on their bedroom walls to collect hourly temperature readings. In the ensuing months, the study team conducted several repeats using this workshop format to ensure that as many residents as possible had completed our pre-intervention survey. Once all ECMs had been installed in units for several months and all possible funded upgrades had been made on the property, the U of M team hosted follow-up workshops to distribute post-intervention surveys to residents and collect temperature monitors. These follow-up surveys included additional appliance, household environment, and health questions in addition to questions to understand participants' satisfaction with the upgrades to their homes. 39 participants took both surveys and, in the post-survey, indicated that they benefited most from LED light bulbs, Wi-Fi-enabled thermostats, and new refrigerators. During this time, the research team decided to collect hourly energy consumption data from participants for a more accurate analysis of energy savings and heating expenditures over the cold months of the study. This data was downloaded from participants' online billing accounts.

Finally, the research team hosted a closing workshop to share preliminary findings from our pre-survey, post-survey, utility bills, and hourly energy consumption data. This series of workshops gave residents an opportunity to digest information about their housing conditions, understand the benefits of small ECMs from Phase 1 of the project, and share information about persisting housing issues. Our energy analysis revealed that over a 4.5-month period from

October 1st, 2022, to February 14th, 2023, our average participant is expected to consume an estimated 750 kW more for heating than in the warmer season, correlating to more than $100. This is significant because all study participants had an average annual income of significantly less than $20,000 or approximately $1,700 monthly.

At the close of Phase 1, the research team learned that there were plans to redevelop the Villages at Parkside in the near future. As there were no additional funded programs available to implement upgrades to this community, it was decided that DOE Home Energy Scores would help the local housing commission and management team better understand the needs of residents as they relate to current home conditions and new homes they may be relocated to.

In late February 2024, our partner energy waste reduction company conducted Home Energy Scores on 10 units, 8 of which were occupied by residents who participated in Phase 1 of the study. Scores were conducted over a period of 4 days and yielded detailed Home Energy Score reports. In addition to visual observations of the homes' construction and the condition of various building materials, the assessor assigned to this project conducted diagnostic blower door tests, building insulation measurements, and a flame test to make the distinction between single- and double-paned windows in each unit. The assessor used inputs from visual and technical assessments to generate Home Energy Score reports with facts about the home's current makeup, generate baseline energy consumption data, and make recommendations, if any, to improve the cost-effectiveness of operating each unit.

Findings

The average Home Energy Score generated for this study is 7.2 out of a possible 10 (Table 1). The lowest score assigned is a 5, while the highest is a 9. An interesting trend that emerges upon closer examination is the inverse relationship between the square footage of the homes and their respective scores. Smaller units yield higher scores, as smaller homes do not require as much energy as larger ones. The average estimated annual savings for residents, with recommended funded improvements, is $47.20. If these basic upgrades were made to units, residents would save approximately 3.23% on annual energy costs.

Table 1. Home energy scores and potential energy and cost savings

Participant unit identifier	Conditioned floor area	DOE home energy score	Annual cost savings with improvements	% of total energy cost savings
1	1,965 SF	6	$0	0%
2	1,034 SF	8	$57	4.5%
3	920 SF	9	$0	0%
4	2,373 SF	5	$38	2.0%
5	1,740 SF	7	$27	1.7%

6	1,740 SF	8	$55	3.7%
7	1,034 SF	8	$105	8.2%
8	1,762 SF	6	$0	0%
9	1,110 SF	9	$23	1.9%
10	1,740 SF	6	$167	10.3%

The categories of Home Facts encompassed in the report for each resident's unit provide a comprehensive overview of the property's structural components and systems (Table 2). These categories, which include Roof/Attic, Foundation, Walls, Windows & Skylights, and Systems, serve as key indicators of the home's overall energy efficiency and performance. Within each category, the report meticulously lists details of the home's current makeup, highlighting areas of strength and potential areas for improvement. From the condition of the roof and attic insulation to the integrity of the foundation and the efficiency of windows and skylights, each aspect is assessed and documented. The report goes beyond mere description by concluding with a set of carefully crafted recommendations aimed at guiding residents and management toward cost-effective repairs and upgrades. These recommendations are tailored to address specific deficiencies identified during the assessment process, with the overarching goal of enhancing energy efficiency, reducing utility costs, and ultimately, elevating the home's overall energy score. As such, they represent invaluable insights that not only empower residents to make informed decisions about their homes but also pave the way for tangible improvements that can yield significant long-term benefits. Now, turning to the observations provided by the Home Energy Score Assessor assigned to this project, we delve deeper into the expert insights gleaned from their firsthand assessment.

Table 2. Observations from home energy score assessor

Home feature	Observation	Recommendation
Roof/Attic	Most units have damaged roofing.	Roofing that leads directly to the home's conditioned space should be repaired first.
Foundation (Floor)	In units with basements, rim joists are poorly insulated, causing leakiness.	Rim joist insulation should be increased to R-19.
Walls	All but one unit has an insulation value of R-7. The remaining unit has no insulation in its walls.	Wall insulation should be increased to R-19.

Windows & Skylights	All units have double-pane windows but did produce some leakiness.	Caulk should be applied to weatherproof windows.
Systems	Most units had high efficiency furnaces, newer model central air units, and high efficiency water tanks.	Furnaces should receive tune-ups and filter changes to maintain efficiency and inhibit dust from collecting on units. Freon should be added to AC units.

The first noticeable observation made by the assessor is several units contained holes in roofing that could be seen from the exterior of the buildings, where some were even covered with tarps in place of roofing. Another observation noted by the assessor is that, in each unit, walls and basement floor rim joists could use additional insulation. Building insulation plays a crucial role in enhancing energy efficiency, comfort, and sustainability in both residential and commercial structures. One of its primary functions is to reduce heat transfer between the interior and exterior environments, helping to maintain a stable indoor temperature regardless of external weather conditions. This thermal barrier not only improves comfort for occupants but also reduces the reliance on heating and cooling systems, thereby lowering energy consumption and utility bills. All walls across our 10-home sample have an insulation value of R-7, with wood frame construction and brick veneer siding. For attics, an R-11 insulation value was measured across attic floors. In cold climates, ENERGY STAR (2024) recommends R-30 insulation for attics in International Energy Conservation Code (IECC) climate zones 5 and 6 where Michigan is located, and suggests R-10 insulative wall sheathing beneath siding. All units in the sample had double-pane windows, which are among the features that likely drove higher scores. Single-pane windows have a single layer of glass, while double-pane windows have two panes of glass, which reflect heat and reduce energy consumption.

Although the last known full-scale renovations conducted on this property were in 1996, heating and cooling units have been updated more recently. This contributed to higher scores for each unit. Most homes in this sample have high-efficiency furnaces, newer central air units, and high-efficiency water tanks with ENERGY STAR labels or other ratings indicating high efficiency (Table 3). Some furnaces were replaced as recently as 2012. According to the assessor handling this project, a furnace that is maintained and receives tune-ups and filter changes as needed will maintain its high efficiency. A well-maintained furnace is expected to last 15 to 20 years but can exceed this lifespan with regular maintenance (Carrier 2024). In the weeks leading up to Home Energy Scoring on this property, the heating and cooling systems in its units received maintenance in preparation for inspections.

Table 3. Efficiency of heating and cooling systems

Participant unit identifier	Gas furnace efficiency (AFUE)	Central air conditioner efficiency (SEER)	Hot water tank efficiency (EF)

1	92%	13	0.67
2	92%	13	0.67
3	95%	13	0.67
4	95%	13	0.67
5	95%	13	0.55
6	95%	10	0.67
7	95%	10	0.67
8	95%	N/A	0.67
9	95%	13	0.67
10	95%	10	0.55

Despite the efficiency of systems and the added benefit of double-pane windows, the assessor did cite leakiness that could be mitigated by increased air sealing measures like caulking windows and adding weather sweeps to exterior doors. In several units, blower door tests generated rather high scores. In a well-sealed building, airflow is typically less than 1,500 CFM at 50 pascals, while airflow above 4,000 CFM is considered leaky (Gromicko 2024). The average CFM across blower door tests in this sample is 2,447. The larger units in the study, similar to the trend in scores, yielded the worst blower door test readings, indicating the most draftiness across units in the study. Blower door tests conducted in the Villages at Parkside (Figure 1) exceeded the 1,500 CFM indicating a well-sealed building by an average of 900 CFM.

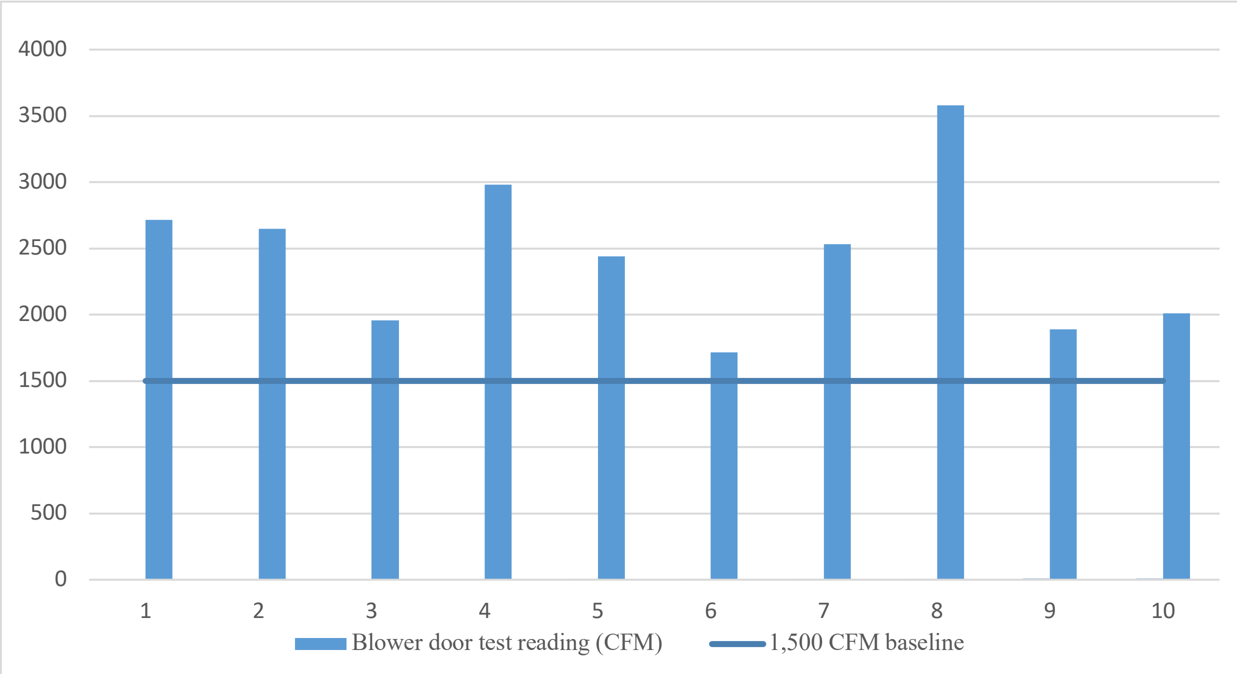

Figure 1. Blower door test readings (CFM) against the 1,500 CFM baseline, which indicates a well-sealed building

Discussion

Energy audits serve as an effective means for identifying contributors to high heating and cooling costs and obtaining detailed information about the efficiency of a structure. Across the 10 homes that received DOE Home Energy Scores as part of this study, the square footage of each unit varied significantly, which made a notable impact on the overall score assessment. It was observed that larger units with basements tended to receive lower scores, whereas higher scores were more common among units with no basements constructed on concrete slab foundations. This difference in scoring can be attributed to various factors such as insulation, air sealing, and ventilation systems, all of which play crucial roles in determining a home's energy efficiency. One noteworthy aspect of the aforementioned townhome units is the presence of double-paned windows, which are considered a positive attribute contributing to higher scores. These windows not only reinforce the structural integrity of the units. There is gas between the panes to enhance insulation and control the transfer of temperatures through the glass, making units less susceptible to draftiness from outdoor air, thereby enhancing overall energy efficiency (BPC Green Builders 2024).

Additionally, while the heating and cooling systems in these units may not receive regular maintenance, their relatively new age, combined with maintenance performed shortly before the Home Energy Scores, suggests that they are high-performing systems. The Home Energy Score utilizes specifications of a home’s HVAC system to generate estimated energy use, and in the case of the units assessed in this study, high heating efficiency values were a contributing factor to increased scores. Specifically, all participants’ gas furnaces were found to have a 95% annual fuel utilization efficiency (AFUE), indicating that nearly all the furnace’s fuel input is effectively converted to heat for the home. Similarly, the use of ENERGY STAR-certified gas water heaters, which are presumed to consume less energy than standard products, further contributed to the high efficiency observed in these units. These water heaters typically have a uniform energy factor (UEF) between 0.65 and 0.95, indicating 65 to 95 cents on each dollar spent (ENERGY STAR 2024). Among units scored for this study, all hot water tanks, except two, fall within this range and have high efficiency.

However, it was noted that low seasonal energy efficiency ratios (SEER) for air conditioning units may have negatively impacted the overall scores. The average SEER for homes in this study was found to be 12, with a SEER rating of 13 being considered low. To qualify for an ENERGY STAR label, central air conditioning units must have a minimum SEER of 14, according to the Air-Conditioning, Heating, and Refrigeration Institute (AHRI 2024). This suggests that upgrading to more efficient air conditioning units could potentially lead to improved energy performance and higher Home Energy Scores for these homes.

While double-pane windows have energy-saving benefits for residents, unless they are adequately maintained, age, heat, and long-term exposure to moisture will eventually cause them to fail. The last known full-scale renovations conducted on this property were nearly 30 years ago. The average life of double-pane windows is 10-20 years. As ENERGY STAR labeling for windows was first introduced in 1998 (ENERGY STAR 2024), windows at the Villages of Parkside are not ENERGY STAR, and at approximately 28 years old, they should be caulked to reseal. Moreover, triple-pane windows have become available and vastly improve in-home resilience to heat flow (U.S. Department of Energy 2010).

As conditioned space (i.e., space within the home's envelope that is required to be heated or cooled) increases, the likelihood of leaks and poor insulation also increases. Poorly insulated rim joists in units with basements contributed to increased leakiness. This is an area where air leaks are common, as it joins the foundation to the rest of the home. Rim joist insulation can help to minimize the stack effect in multilevel structures. The stack effect requires outdoor temperatures to be substantially colder than indoor temperatures and results in the warmer, indoor air pressing upward and escaping through various openings on higher levels of the structure (Elliot and Miller 2019). Rim joist insulation is especially important to residents of these units, as they specifically expressed frustration with temperature imbalances between downstairs and upstairs. Each unit additionally contains an attic. However, attics are sealed in some units, which inhibited our DOE Home Energy Score assessor from accessing and documenting insulation levels in the space.

Although the assessor could not make upgrades to units in response to findings from the DOE Home Energy Scores, the recommended air sealing measures are much more cost-effective than roofing improvements or insulation upgrades. Eventually, management may decide to perform caulking and air sealing due to the relatively high return on investment. Nazeriye et al indicate that residents in single-family detached homes are more likely to lend attention to caulking when compared with other types of housing. Moreover, families living in owned houses, seal [these] openings, whereas tenants are not attentive to this behavior (Nazeriye 2021). The likelihood of renters taking the initiative to use personal dollars or time to make these upgrades is perhaps even lower for resource-constrained tenants with low income.

Fortunately, the Inflation Reduction Act (IRA) passed by the Biden-Harris administration provides $8.8 billion for home Energy Rebates and Home Electrification and Appliance Rebates administered by states, territories, and tribal governments to distribute to owners of single-family buildings and multifamily homeowners (U.S. Department of Energy 2024). On May 30, 2024, Michigan's Governor announced a $367 million grant through the U.S. Department of Energy's Home Energy Rebate program and the U.S. Environmental Protection Agency's Solar for All program. The funds are expected to cut utility costs for 28,000 low-income households and help install solar panels on 18,000 homes (State of Michigan 2024).

The Biden administration's Justice40 Initiative directs 40% of the overall benefits of certain Federal investments – including investments in clean energy and energy efficiency; clean transit; affordable and sustainable housing; training and workforce development; the remediation and reduction of legacy pollution; and the development of clean water infrastructure – to flow to disadvantaged communities (DACs) (U.S. Department of Energy 2022). This initiative means that disadvantaged communities, including communities like the Villages of Parkside, will participate in the unprecedented investment in housing.

Vale (2017) discusses collaboration between tenant groups, housing authorities, and private management companies as a potential driver of positive outcomes in public housing policy, which could contribute to successful public housing redevelopment efforts. The author highlights Recognized Design Quality and Enhanced Maintenance and Management Performance among seven criteria used to measure the success of public housing redevelopment projects. The ENERGY STAR score for homes is a separate metric used to evaluate the energy efficiency of residential properties in the United States. To earn the ENERGY STAR label, new multifamily buildings consisting of apartment units must meet recommendations outlined by the U.S. Environmental Protection Agency (ENERGY STAR 2024). This tool could potentially align well with the modular-style multifamily apartment homes proposed as part of the redevelopment plan for the Villages at Parkside. Since the ENERGY STAR score is specifically designed to certify apartments and condos, it may be an appropriate tool to use on the new homes proposed as part of the upcoming redevelopment in this community. One downside of this tool, however, is that it uses a building-wide approach and will not yield as much detailed information on individual units as the DOE Home Energy Score.

Study Limitations

The U.S. Department of Energy Better Buildings Initiative (2024) cites the DOE Home Energy Score as a tool created for single-family homes, townhouses, and duplexes. The average size for a townhome unit is between 1,000 and 3,000 square feet (Missing Middle Housing 2024). For townhomes like those in the Villages at Parkside, originally built in the 1930s and last updated nearly 3 decades ago, there is significant wear on building materials and it is unlikely for a DOE Home Energy Score of 9 to actually be achieved. Our study finds that significantly low scores are strongly correlated with units with larger square footage, while higher scores are correlated to units under or just over 1,000 square feet. In this sample, some units were as small as 920 square feet and did not meet the criteria for a townhome-style housing unit. For smaller homes, heating and cooling needs are lower and residents have lower gas and electric consumption. The DOE Home Energy Score method does not control for floor size to the extent that a unit smaller than 1,000 square feet should have its efficiency assessed on the same scale as that of a 2,000 or 3,000-square-foot unit. The score makes a more general comparison of the efficiency of these units to that of an average single-family U.S. home and relies heavily on system inputs to estimate building performance and energy expenditures. The score is a direct function of the estimated energy consumption in each unit and does not control for floor area or other factors.

For our study, the estimated annual cost savings as a result of implementing the recommended measures are more relevant to our analysis. For residents in the Villages at Parkside, the most beneficial outcome of DOE Home Energy Scores will likely be the application of smaller, cost-saving measures that can be implemented by management at low cost. Rather than focusing on the score, researchers will utilize estimated annual cost savings with recommended improvements and the corresponding percentage of annual energy savings to communicate the benefit of air sealing (caulking and spray foam) to management. The scoring process itself provides an increase in energy management knowledge across study participants. Several residents, for instance, were unaware that their homes had attics and believed them to be crawl spaces. This offered the assessor an opportunity to make the distinction between attics and crawl spaces, which are actually located underneath a structure. Another important fact to note is that before 1970, most residential homes were not insulated at all due to different living standards as energy and fuel costs were much lower (State of Illinois 2024). This scoring procedure, while perhaps not the best fit for units this size, allowed residents to engage the Home Energy Score to better understand current building and insulation standards.

Conclusions & Recommendations

In Phase 1 of this research basic energy-conserving measures were installed in an effort to quantify energy and monetary benefits of a utility-offered energy efficiency program carried out in low-income multifamily housing. Findings from this phase of the intervention indicated no significant trend in savings before and after these basic measures were installed. Some residents used less energy after upgrades were installed, while others did not. The program administered during Phase 1 of this study provided baseline direct install measures but did not include recommendations relevant to any of the Home Feature categories in the DOE's Home Energy Score tool. To reveal any deeper retrofits that may result in more significant savings to residents, Home Energy Scores were performed in Phase 2 of the study. Although the DOE Home Energy Score may not provide the most accurate one-to-ten efficiency scores for units with small square footage, it does offer valuable recommendations for reducing energy consumption and costs, which can be particularly beneficial for residents with annual incomes under the federal poverty level. Even small annual cost savings can significantly impact their financial well-being cumulatively over time.

Despite the limitations of the tool, the Home Energy Score serves as an easy-to-understand and informative means for residents to validate ongoing concerns, especially those related to draftiness and temperature disparities between different levels of their homes. In response to recommendations made by the Home Energy Score Assessor, this property's management should consider investing in window caulking solutions and small pieces of rigid foam board to seal attics as well as spray foam for basement rim joists. These air sealing measures, while not requiring the purchase of new heating or cooling equipment, are likely to increase the efficiency of each unit and provide additional comfort benefits to residents. The upgrades are the lowest-hanging fruit on the path to lower energy costs and increased comfort for residents.

For units that received very low scores, in some cases, implementing the basic recommended improvements did not result in any estimated improvement to the score. This is understandable because, as best practice, a new building is designed to operate as a holistic system, with the building envelope, the building systems, and how the building is used largely determining the energy consumption and cost of operation. As the building envelope and its systems age at different rates, operating imbalances are created, causing one or more systems to work harder to accommodate the inadequacies created. For instance, a hole in the roof of a building envelope will cause the heating and cooling systems to have to work much harder to condition more air to maintain desirable temperatures. As the heating and cooling systems age, particularly with poor maintenance practices, their components (i.e., pumps and fans) may have to work harder to achieve the same results. As the number of appliances and electronics are added, the building needs more electricity to operate. As a result, the cost to operate the building, the building comfort, and many times even the safety of the building can be compromised. In these cases, installing basic low-cost utility-funded energy conservation measures cannot overcome the problems associated with aging infrastructure and increased energy requirements. As the Home Energy Score assessment indicates, addressing aging infrastructure issues such as holes in roofs and systems approaching the end of life requires deep and expensive retrofits.

Neither the Home Energy Score tool nor the ENERGY STAR rating system, both of which are widely utilized mechanisms for evaluating energy efficiency, prove to be entirely optimal for accurately assessing the energy performance of townhome-style units, especially those situated within aging public housing complexes characterized by unique architectural configurations and historical infrastructural constraints. Recognizing this gap, it becomes imperative for federal agencies, utilities, housing commissions, non-profit organizations, and other public housing stakeholders to engage in collaborative efforts aimed at refining existing tools or developing new ones that can better accommodate the unique characteristics of such housing. While it may not be feasible to entirely replace these established rating systems, there is certainly room for improvement by adapting their foundational principles to better align with the specific needs and challenges of dated public housing. This collaborative approach ensures that the energy efficiency of these housing units can be accurately assessed and addressed, ultimately leading to more effective and targeted interventions aimed at reducing energy consumption and improving overall sustainability.

For the housing units not designated for immediate redevelopment during the initial phase of construction on the property, these scores have been conducted to ensure effective management and sustainability. Detroit's local housing commission and/or a separately operating property management company in the Villages at Parkside will play integral roles in overseeing these units. This collaborative effort should aim not only to maintain the existing infrastructure but also to enhance energy efficiency and overall livability. Through the utilization of the 10 DOE Home Energy Score Reports included in the study, tailored plans can be developed to address specific needs and optimize energy usage in the interim. By integrating these reports into decision-making processes, stakeholders can implement targeted improvements, such as insulation upgrades, appliance replacements, and renewable energy installations, thereby reducing utility costs and environmental impact while simultaneously improving the quality of life for residents. This approach underscores a commitment to long-term sustainability and community well-being, ensuring that every aspect of the property aligns with modern standards and best practices for energy-efficient multifamily housing.

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