Integrating Energy Efficiency and Solar Resources to Benefit Affordable Multifamily Buildings

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ABSTRACT

A growing number of private-sector investors are financing solar projects that benefit affordable multifamily buildings. Several states have adopted policies and programs to encourage these investments, but owners of affordable multifamily buildings still face many uncertainties in the solar marketplace. These include the fact that utility rates for solar energy vary greatly by location and time, building owners often have difficulty securing funding for solar projects, and solar incentive programs may operate with challenging timelines or application requirements.

Energy efficiency, the most cost-effective and cheapest energy resource, can mitigate many of the risks associated with investing in solar energy. Our research examines several case studies of leveraging affordable multifamily investments in energy efficiency with those made in solar projects. Combined with solar, efficiency upgrades can achieve high energy cost savings for affordable multifamily buildings, allowing owners to preserve and create more affordable housing for low-income households. The success of these efforts offers several lessons for policymakers and energy efficiency program administrators.

Introduction

Forward-looking affordable multifamily building owners are finding that both rooftop solar systems and energy efficiency upgrades can be sensible investments, given the right mix of economic and policy incentives.[1] Two-thirds of multifamily buildings were built before the advent of energy codes and so tend to have many structural inefficiencies (Henderson 2015). Utility bills are often an affordable housing provider's largest unpredictable expense, and efficiency and solar technologies can lower these costs to help providers offer affordable housing and other needed services (Garren et al. 2017).

Methodology

Until now, few researchers have examined how affordable multifamily building owners are able to reduce their energy costs using energy efficiency and solar resources. Because there is no national dataset of these initiatives, we conducted interviews with leaders from four projects and programs that have combined these technologies in affordable multifamily buildings. Our questions focused on each project or program's planning, goals, funding sources, and lessons learned. These participants also provided us with detailed performance data for projects. While

[1] We define *affordable housing* in keeping with the definition used by Henderson (2015): "Housing that is subsidized through federal and state programs, such as the Low Income Housing Tax Credits, and unsubsidized housing deemed 'affordable' because of rent levels." In keeping with previous research by Samarripas, York, and Ross (2017), we define *multifamily buildings* as those with five or more housing units.

we do not consider these case studies to be representative of all affordable multifamily energy efficiency and solar projects, our analysis may provide insights into challenges and effective approaches for planning, financing, and implementing such efforts.

Background

Financial Benefits of Energy Efficiency and Solar Projects

Affordable housing providers have ample reason to lower their energy use and costs. Reducing these costs increases an owner's net operating income (NOI) from a building and the value of the property itself.[2] For a nonprofit affordable multifamily housing provider, increases in property value can be important to stabilize building finances and expand borrowing capacity with lenders. Owners who reduce utility expenses and increase NOI can ultimately improve their ability to preserve or expand affordable housing.

Owners who make efficiency improvements to their building reduce a property's total energy demand. This decreases the size and attendant cost of building PV systems. The net result is a more affordable package of energy-saving technologies for property owners. Housing providers and investors who take a holistic view of how energy resources affect one another can discover opportunities to achieve deep whole-building energy savings at less cost. For example, several housing providers have leveraged the utility costs savings from measures with faster paybacks to invest in those with longer paybacks.

Policy Environment for Integrated Energy Efficiency and Solar Projects

Policymakers' and utility regulators' decisions affect whether affordable multifamily buildings can accommodate both energy efficiency and solar resources. The projects we document in our research have occurred in cities or states with a supportive policy environment for energy efficiency, solar energy, and affordable housing. We identify four policy areas that can support and drive the market for integrated energy efficiency and solar in affordable multifamily housing. These include federal, state, and local policies and incentives as well as utility regulation. Our policy review highlights initiatives that most affect the deployment of both energy efficiency and solar resources. It is not intended to comprehensively describe all such policies or programs.

Policies and programs at these various levels must complement and support each other. Projects that successfully integrate solar with energy efficiency will generally package and leverage relevant incentives and financing options from a variety of sources.

Federal policies and incentives

The federal solar investment tax credit (ITC) has been a critical subsidy for solar installations, and all interviewees stated that it has been an important source of project funds; however it is unclear how effective it will be in the future (Garren et al. 2017). While in recent

[2] Property values are calculated by dividing a building's net operating income (NOI) by its expected rate of return, also referred to as its capitalization rate. Capitalization rates rise and fall with interest rates, so owners must find ways to increase NOI when interest rates rise (WegoWise 2017a).

years the ITC has provided a 30% credit for solar installations on residential and commercial properties, the credit's value is slated to decrease starting in 2020.

The Community Reinvestment Act (CRA) has also helped provide financial support for energy efficiency and solar projects in low-income and minority communities. In 2016, three regulatory agencies responsible for overseeing CRA compliance issued guidelines stating that lending for projects reducing affordable housing energy costs would be assessed favorably on CRA reviews (NLIHC 2017). Many banks will lend to community development finance institutions (CDFIs) to make such investments on their behalf. CDFIs will often then pair this funding with funds from other sources to back projects.

Regulations issued by the US Department of Housing and Urban Development (HUD) can also affect the deployment of energy efficiency and renewable energy resources in affordable housing. For example, owners of multifamily properties receiving housing subsidies who demonstrate they will pursue and achieve an industry-recognized green building standard and an ENERGY STAR® score of 75 or better may be eligible to reduce their Federal Housing Authority (FHA) mortgage insurance premium (HUD 2016). Beyond this, many HUD-assisted properties have little incentive to reduce energy costs as these savings will be largely recaptured by HUD through reductions in utility cost subsidies for owners (Henderson 2015).

State policies and incentives

States with both an Energy Efficiency Resource Standard (EERS) and Renewable Electricity Standard (RES) or Renewable Portfolio Standard (RPS) are more likely to have programs that incentivize the use of efficiency and solar resources in affordable multifamily buildings. EERS policies create energy savings targets for utilities and nonutility energy efficiency program administrators (ACEEE 2017a). These goals drive administrators to provide utility customers with energy efficiency incentives. RES and RPS policies require that electric utilities generate a certain amount of electricity from renewables or meet these goals by purchasing renewable energy credits (RECs) created by private market solar projects (Garren et al. 2017). These policies provide many solar projects with needed funding.

States such as California apply funds from greenhouse gas emission cap and trade auctions to programs that incentivize multiple energy resources, provided they are used to meet specific environmental goals. California Assembly Bill 398 (2017) requires that auction proceeds be used to reduce air pollution, support clean energy technologies, and improve environmental quality. California has also adopted a requirement that at least 25% of auction revenue be used in programs for underserved communities (California Senate Bill 535 2012).

State and local governments can also create green banks to integrate energy efficiency and solar resources in affordable multifamily buildings. Gilleo, Stickles, and Kramer (2016) assert that green banks "leverage public funds to stimulate private capital investment and typically provide resources above and beyond financing to support demand, including technical assistance and coordination with other clean energy entities" (iii). Green banks focus on achieving the highest return on investment possible, regardless of the energy technology being financed, while increasing the health, durability, and affordability of multifamily buildings.

State Housing Finance Agencies (HFAs) can also incentivize Low-Income Housing Tax Credit (LIHTC) projects to incorporate energy efficiency and renewable resources through provisions of qualified allocation plans (QAPs). In addition to specifying project requirements, each QAP details the scoring system used to evaluate applicants for tax credits. Gittlin (2017) found that these plans awarded points for energy efficiency more often than for other types of

sustainability improvements in buildings. Twenty-eight state plans awarded points for both energy efficiency and solar in 2017.

To encourage investments that reduce renters' energy use, some state HFAs allow affordable multifamily building owners to increase unit rents after accounting for tenant energy savings. Affordable multifamily buildings receiving housing subsidies are generally obligated to keep the combined cost of rent and utilities below 30% of a household's income. To do this in an individually metered building, owners reduce rents to compensate for tenants' expected utility costs. These accommodations are referred to as *utility allowances*. When renters' utility costs decrease, owners in certain states can use energy consumption modeling or actual tenant utility consumption data to adjust utility allowances and increase rents (Bartolomei 2017). This increases the owner's cash flow and provides a return on their energy-saving investment.

While using utility allowance adjustments to increase rents leads to greater cash flows for owners, such actions come with a risk for renters. If residents' energy savings meet projections, they will see little or no net change to their household expenditures. Increases in rents will largely negate any decrease in utility costs. If energy efficiency upgrades and solar equipment fail to meet expectations, renters can see a net increase in their household expenses after accounting for rent increases (Stone et al. 2004). Any HFA allowing project-specific utility allowances can help prevent unjustified rent increases by ensuring that agency staff know how to verify the energy savings used to increase rents (Bartolomei 2017).

Local policies and incentives

Local governments can also use policies and incentives to integrate renewable energy and energy efficiency upgrades in affordable multifamily housing. Cities can be important in facilitating community partnerships and providing real estate development incentives for green, affordable housing. We profile Washington, DC's, approach in this regard.

Cities with a municipal utility can provide incentives for energy efficiency upgrades and solar PV that are tailored to meet the unique needs of affordable housing within their respective communities. This scale allows a more focused, responsive approach than is offered by utilities having large service territories with many cities of varying sizes that include rural and suburban areas. In our case studies, we highlight Austin as such an example.

Utility regulations and policies

Utility regulation is pivotal in supporting both energy efficiency programs and distributed energy generation such as solar PV. Several aspects of utility regulation can affect the viability and strength of programs and services for affordable housing projects integrating energy efficiency with renewable energy. These include the approach to distributing customer incentives, rates and rate structures, and distributed generation policies.

Customer incentives and services from utility energy efficiency and solar programs support projects reducing affordable housing energy costs. Incentive payments to property owners for qualified energy efficiency measures are typically a critical component of the overall funding bundle needed for a project to move ahead. Regulators motivated to ensure equity among customer classes can require that utilities fund and provide energy efficiency and renewable energy programs that specifically target and serve affordable multifamily customers.

The economics of energy-saving projects are a function of utility electricity rates and rate structures. Electricity rates are a primary determinant of the returns on solar investments.

Customers that pay higher rates tend to spend more on their electricity bills and have a greater motivation to invest in energy-saving improvements. Net energy metering (NEM) is closely related. NEM is a metering and billing arrangement to compensate owners of solar or other distributed generation for electricity that is exported to the grid (Aznar 2017). NEM policies and rate structures vary widely across the 44 states (and DC) where policies are in place. Some NEM policies and rates are supportive of distributed generation while others may hinder such developments.

Related distributed generation policies also play a large role in determining the market for customer solar energy. Technical requirements for connecting distributed resources and providing power to the grid vary across the United States. Such variations affect the relative ease for property owners to become distributed energy providers.

Examples of Existing Projects and Programs

The following case studies highlight programs and projects that have worked to combine both energy efficiency and solar resources in affordable multifamily buildings. These were made possible through a combination of policies and strategies employed by program and project leads.[3]

California's Low-Income Weatherization Program for Multifamily

California's Low-Income Weatherization Program for Multifamily (LIWP-MF) obligates participants to reduce energy use with efficiency measures before installing a solar system. The state's Department of Community Services and Development (CA CSD) administers the program, with implementation led by the Association for Energy Affordability (AEA) and supported by GRID Alternatives, the California Housing Partnership (CHPC), and TRC Companies.[4] The program provides affordable multifamily building owners with comprehensive technical assistance and financial incentives to install rooftop solar systems, solar water heating equipment, and energy efficiency upgrades.

LIWP-MF has also effectively addressed the challenges and risks associated with investments that offset tenant energy use and costs. Most multifamily buildings are individually metered, and many owners of these buildings are unable to reasonably justify how a project that reduces renters' energy expenses will generate returns for investors (Samarripas, York, and Ross 2017). This challenge is typically referred to as one of split incentives because residents of these buildings will reap the direct financial benefits of an owner's energy-saving investment. LIWP-MF addresses this issue by providing generous incentives for owners installing efficiency upgrades and solar systems that directly benefit renters.

Currently, projects are eligible for an incentive of $3,000 for each metric ton of CO_2 equivalent (Mt CO_2e) reduced by energy efficiency measures that affect the building's owner-paid energy. Incentives increase to $4,500 for each Mt CO_2e reduced by efficiency measures tied to renter-paid energy. To qualify for rooftop solar incentives, projects must achieve 15% whole-building energy savings using energy efficiency upgrades. Rooftop solar incentives can range

[3] For more detailed descriptions of these case studies, see Samarripas and York (2018).

[4] Stone Energy Associates has been helpful in assessing the program's rate and billing impacts and designing the program with a consideration for the needs of properties receiving LIHTC. Similarly, Waite and Associates has been helpful in providing program administrators with solar financing information.

from 50% to 100% of a rooftop solar system's cost and are dependent upon the size of the system, the type and amount of leveraged funds, and whether the system serves common or tenant spaces. The highest rooftop solar incentive levels are reserved for systems that benefit tenants. These are covered at 100% of cost.

LIWP-MF staff also work with partner organizations to reduce the chance that a project will not succeed (CA CSD 2016). For example, the CHPC has been a critical partner in recruiting program participants from its affordable housing programs. CHPC staff will ensure that applicants meet the program's housing affordability requirements and have the capacity and funding to complete a project on schedule.

Program incentives cover roughly 70% of most LIWP-MF project costs, but these funds are not awarded until all work is completed. Because of this, the only applicants selected to participate are those with substantial cash reserves or access to other funding sources that can cover upfront costs. Even with the program's robust screening process, providing the upfront funding needed for larger energy-saving projects can challenge participants. To assist with larger projects, program staff have broken the work into phases so that incentives can be awarded periodically throughout the course of the project.

LIWP-MF's overall results have been positive. The program is reducing affordable multifamily building energy use by an average of 44% and is projected to save more than $48 million in utility bill costs and 120,000 Mt CO_2e over the next 15 years (CA CSD 2017). Rooftop solar systems account for roughly half of LIWP-MF energy savings and greenhouse gas emission reductions. Energy efficiency upgrades to windows and hot-water systems reduce the most greenhouse gas emissions while window and lighting upgrades save the most electricity.

National Housing Trust Enterprise Preservation Corporation and St. Dennis Apartments in Washington, DC

The National Housing Trust Enterprise Preservation Corporation (NHT-Enterprise) works to preserve, improve, and maintain affordable housing throughout the United States (DOE 2015). As a real estate developer and lender, NHT-Enterprise has been involved with several affordable multifamily projects that installed both energy efficiency upgrades and rooftop solar systems to reduce utility costs.

NHT-Enterprise has faced challenges obtaining upfront funding for large projects that integrate both efficiency and solar resources. While NHT-Enterprise has access to substantial capital, its resources are still limited. It must make decisions about how to prioritize energy cost-saving projects considering other building needs. Solar and energy efficiency incentive programs can complicate this decision making with short timelines for receiving incentives and completing projects. Short and conflicting program timelines also add to the difficulties of completing project predevelopment work. Predevelopment work involves assessing the scope, feasibility, and financing for a project. This phase is not only costly but also risky for investors because project completion is still uncertain. NHT-Enterprise established a separate entity called NHT Renewable to develop, own, and operate solar systems across its portfolio of buildings. A portfolio approach was necessary to attract more private investors to solar projects. It has also been helpful in achieving efficiencies of scale by distributing large predevelopment costs across work on several individual buildings.

NHT-Enterprise is focused on completing energy efficiency and solar projects in locations with the most favorable policies, incentives, and electricity rates. The District of Columbia Sustainable Energy Utility (DCSEU) provides multifamily building owners with both

energy efficiency and solar incentives. Because of this, Washington, DC, has proved to be a favorable location for several NHT-Enterprise projects, and St. Dennis Apartments was one of the organization's first projects in the city to integrate both efficiency and solar resources. St. Dennis Apartments is a 32-unit affordable multifamily building that was vacant and in disrepair before NHT-Enterprise agreed to renovate the property. The organization has since installed several health and safety improvements, energy efficiency upgrades, water conservation measures, and a 250-kW rooftop solar system. These measures accounted for roughly 15% of the project's $10.2 million rehabilitation budget.

Today, the building stands fully occupied, and utility allowances are roughly 40% lower than before the building was acquired and renovated. The lower utility allowance has allowed the owner to set higher, but still affordable, rents. This has increased the building's cash flow. Due to this and the other improvements made to the building during its rehabilitation, the market value of the property has nearly doubled, from $3.2 million to $6.2 million.

Connecticut Green Bank and Plaza on the Green in Waterbury, CT

The Connecticut Green Bank provides affordable multifamily building owners with financing for both energy efficiency upgrades and rooftop solar installations. Cost savings from energy efficiency and solar resources are used to cover debt issued by the green bank. Staff coordinate their work with energy efficiency initiatives led by state agencies and utilities, factoring utility incentives for energy efficiency upgrades or solar installations into all projects.

The Connecticut Green Bank provides unsecured loans to owners of properties serving low-income residents, meaning lenders have no claim to collateral in cases of default. This is helpful for many affordable multifamily projects because their investors are often wary of owners taking on additional debt that may interfere with investors' claims to collateral in the event of default. Because it offers unsecured loans, the Green Bank has evolved to serve two primary types of affordable multifamily projects: those that are seeking deep energy savings and those that have limited financing options for capital upgrades. The Green Bank assists physically and financially distressed properties by providing access to debt that is not secured by property. Owners pursuing deeper retrofits use green bank financing because financing sources are often limited in the underwriting value they ascribe to potential energy savings.

Plaza on the Green, an affordable apartment building in Waterbury, CT, has been undergoing a deep energy-saving project with assistance from the Connecticut Green Bank. This 12-story, 157-unit building has experienced significant financial and physical distress in recent years. The building's owner has been responsible for paying all utility costs. Before installing energy- and water-saving measures, annual utility expenses totaled approximately $440,000 and accounted for 27% of the owner's total operating expenses. While the owner had ample reason to invest in such measures, improvements to the building first required structural masonry repairs projected to cost $350,960. Combined with the cost of other health and safety upgrades, the repairs accounted for nearly one-fifth of the project's $2,950,960 work scope. In addition to the large project cost, the owner faced challenges securing financing because the existing debt was greater than the appraised value of the building, and state housing finance agency regulations placed limitations on supplemental financing.

To provide sufficient financing, the Connecticut Green Bank partnered with two CDFIs to offer the building owner a blended-rate Low Income Multifamily Energy (LIME) loan. Capital for Change (C4C) provided $1.75 million in capital, and the Connecticut Green Bank backed this

investment with a loan loss reserve.[5] C4C required that the building owner pay for masonry repairs as a precondition for their investment. The Stamford-based Housing Development Fund (HDF), along with the MacArthur Foundation, provided the remaining needed capital in the form of an $850,000 nonrecourse loan.[6] Utility energy efficiency incentive programs provided an additional $101,609 in incentive funding. Operating risks are being mitigated by including a training program for staff and residents once construction is complete, conducting site visits during the installation period to optimize energy savings, and requiring ongoing remote monitoring by an energy benchmarking services company. Because of the Connecticut Green Bank's approach, the building's energy costs are anticipated to be $248,303, a 44% decrease.

While Plaza on the Green is realizing substantial cost savings from the installation of energy efficiency and water conservation measures, project leads chose to remove plans for a rooftop solar system that was initially included in the work scope. The system was excluded because, in reviewing all cost-effective options for the building, PV had a small first-year payback relative to its upfront cost. Plaza on the Green is a tall building with limited roof space and difficult access for construction work. This limits the potential size of a rooftop system and increases installation costs. The system would have cost $170,000 to install but would have resulted in a first-year net savings of only $9,500. The owners are instead replacing the building's inefficient electric water-heating system with more efficient natural gas equipment. They are also installing a forced hot-water natural gas heating system. While these systems are $1,825,814 in combined costs, they will result in first-year net savings of $191,000. The higher savings are important because the project's LIME loan qualifies applicants based on first-year, not lifetime, savings.

Foundation Communities and Arbor Terrace in Austin, TX

Foundation Communities in Austin is a nonprofit affordable housing provider focused on improving the financial and social welfare of low-income families and individuals. To that end, the organization's leadership concentrates on developing multifamily housing that provides residents with affordable rents and environmentally sustainable building systems. Foundation Communities prioritizes energy-saving improvements for their properties because they benefit the health, well-being, and financial stability of their residents.

The organization plans energy cost-saving projects to minimize opportunity risks, and project managers take different approaches for new construction and existing buildings. New construction housing projects are planned with the goal of saving as much energy as is financially feasible beyond energy code requirements. High-efficiency building systems receive priority in these project budgets, and the remaining resources are used to fund renewables. Under this approach, some projects may not initially include solar PV, but all buildings are designed so that these systems can be easily added later.

In contrast to new construction projects, energy efficiency and renewable resources will only be considered for an existing building if they have a 10-year or less payback. Foundation

[5] Loan loss reserves are financial guarantees for a portion of loaned funds that make lenders whole if borrowers do not make payments according to agreed-upon terms. Lenders can establish these reserves using their own capital or work with a third party to set them up. These third parties are often state or local governments in clean energy and energy efficiency financing. For more information, see ACEEE (2017b).

[6] Nonrecourse loans are secured by collateral, which is usually real property. Lenders cannot hold borrowers personally liable for nonrecourse loans.

Communities leadership places a priority on being able to continually consider buildings for energy efficiency retrofits or renewables using contemporary technologies. In their experience, energy technologies can become outdated over a 10-year period.

Foundation Communities has been able to continually make substantial investments in the latest energy technologies for several reasons. The organization describes itself as a "forever owner" of buildings, meaning it does not plan to sell its properties. Thus, project managers can plan for new construction projects that include energy-saving measures with longer payback periods. The organization's substantial capital reserves have allowed them to pursue energy efficiency retrofits at times other than a planned renovation or refinancing. These resources have also been helpful in installing rooftop solar systems when a tax equity investor was not available to monetize the value of a solar ITC. Energy efficiency and solar incentive programs administered by Austin Energy, the city's municipal utility, have proven to be an important funding source for projects. Finally, Foundation Communities stresses that energy efficiency and solar projects would not be possible without strong partnerships with several organizations and companies. Leadership and staff have established strong working relationships with organizations such as Enterprise Community Partners and reliable vendors, architects, and engineers.

Arbor Terrace, a Foundation Communities apartment property, was an extended-stay hotel before being acquired and renovated in 2012. Hotel rooms were converted into 120 efficiency apartments with high-efficiency water fixtures, ENERGY STAR–compliant lamps, and heat pump air conditioners equipped with occupancy sensors. Metal roofing was installed to increase the roof's surface reflectivity, reduce heat gain, and decrease the building's need for cooling. A 76-kW solar PV system was also added to the roof with the capacity to generate 104,366 kWh of electricity annually. As shown in Table 1, the building annually uses and pays for substantially less energy and water than the national median.

Table 1. Annual whole-property energy and water use

Property	kBtu per ft^2	Gallons of water per ft^2	Utility cost per ft^2
National Median	59.6	121.0	$1.58
Arbor Terrace	41.0	27.8	$1.15

Energy use is reported as site energy. *Source*: Fannie Mae (2014) and EPA (2016).

Recommendations

To successfully integrate both energy efficiency and solar resources into their buildings, affordable multifamily owners are combining incentives, financing, and predevelopment support from multiple sources. Our case study research suggests that program administrators and policymakers should pursue the following actions in creating and implementing initiatives.

Offer solar incentives to affordable multifamily owners with the condition that applicants also install energy efficiency upgrades

Installing weatherization improvements along with high-efficiency lighting, appliances, and easy-to-operate equipment allows rooftop solar systems to be correctly sized and helps mitigate the risk that projects will fail to meet energy savings projections. Programs should not

only conduct energy efficiency upgrades, but also require solar installers to account for how these improvements will affect the building's energy use and need for a solar system.

Fund project predevelopment work or provide staff to assist with project planning

Affordable multifamily building owners wishing to install both energy efficiency upgrades and solar systems often have limited staff and funding to complete project predevelopment work. Programs will need to provide participants with added financial or staff support for the early stages of project planning.

Educate building residents and staff on the installation, operation, maintenance, and benefits of energy-efficient equipment and solar systems

New building technologies must be properly operated and maintained to ensure they achieve projected energy cost savings. Educating renters and building staff is important for reducing operating risks.

Require that program participants use energy benchmarking services and software

Combined energy efficiency and solar projects tend to be large undertakings that require substantial investment. To ensure these projects generate anticipated savings and financial returns, programs should require that participants use benchmarking services and software to monitor their building's energy performance after project completion.

Programs that encourage energy efficiency upgrades alongside solar installations should provide large incentives or financing for owners to reduce renters' energy use

Incentives or green financing options are needed to help cover the high costs of providing renters with in-unit efficiency upgrades or rooftop solar systems that offset their energy bills. For example, the California LIWP-MF program has been successful in incentivizing these investments because it fully funds rooftop solar systems that offset renter energy bills and provides owners with greater funding for in-unit efficiency improvements.

Provide affordable multifamily housing providers with financing opportunities that underwrite energy cost savings

Energy efficiency and solar projects that benefit renters may be possible with lower incentives if green financing options are available. For example, Fannie Mae offers multifamily owners a Green Rewards loan that can be used to underwrite 25% of tenant energy savings if the project reduces building-wide energy or water use by at least 20% (Fannie Mae 2016). Green banks, like Connecticut's, can also play an important role in financing the integration of energy efficiency and solar resources in affordable multifamily buildings.

Conclusions

While our research indicates that combining energy efficiency and solar resources in affordable multifamily buildings can result in substantial energy cost savings and assist housing

providers in their mission to preserve and increase affordable housing, a larger systematic study of these projects and programs is needed. We have analyzed only a small sample of completed projects and active programs.

We conclude that solar projects have the potential to encourage energy efficiency investments in affordable multifamily buildings. Our research reveals that housing providers installing solar systems are making weatherization improvements, upgrading lighting, adding high-efficiency appliances, and educating both building staff and residents on these changes to the building. It is critical that policymakers and program administrations encourage or require owners to make these investments in addition to installing a solar system. Doing so helps hedge against operating risks associated with solar systems and other newer, emerging technologies.

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