# Our Powers Combined: Energy Efficiency and Solar in Affordable Multifamily Buildings

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## Executive Summary

The production and consumption of energy can burden the health, well-being, and finances of people living and working in low-income and minority communities. To mitigate these effects, policymakers and utility regulators have developed policies and programs that increase access to both energy efficiency and solar resources for low-income households. Some affordable multifamily housing providers are now finding that investments in both energy efficiency and solar resources can result in substantial utility cost savings.

Little is known about how affordable multifamily building owners and developers approach the integration of efficiency and solar resources in a building. Programs and policies that support these projects have received limited attention. To address this, we interviewed several program administrators, affordable housing providers, and lenders who have taken part in projects involving both efficiency upgrades and rooftop solar installations in affordable multifamily buildings. Our interviews included questions regarding planning, goals, funding sources, and lessons learned. We also analyzed program and project data, where available, and profiled four organizations with a successful record of integrating energy efficiency and solar resources in affordable multifamily properties.

### *BACKGROUND*

The affordable multifamily housing providers featured in this report have two primary motivations to pursue energy efficiency and solar projects. First, they want to reduce utility costs and improve their financial capacity to preserve and expand affordable housing. Utility bills are often an affordable housing provider's most unpredictable expense. Energy efficiency and solar technologies can lower these costs to help owners provide housing and other needed services to low-income individuals and families. Providers also want to reduce pollution that disproportionately affects the low-income and minority families they serve and guard against the risks associated with a changing climate. Some building owners are finding that combining energy efficiency and solar resources can achieve both these goals while providing substantial positive returns for investors.

Policymakers and regulators in several locations across the country are also taking actions to support affordable-multifamily energy efficiency and solar projects. The federal government provides limited, but important, support for these efforts through its solar investment tax credit (ITC), and federal regulatory decisions have encouraged banks to back energy efficiency and solar projects in low-income communities, often through investments in community development finance institutions (CDFIs). The US Department of Housing and Urban Development also affects the deployment of energy efficiency and solar resources in its regulations governing subsidized affordable multifamily buildings. Some states are adopting energy savings targets and distributed generation requirements that spur utilities to make investments in efficiency and solar installations, such as through customer incentives. They may also support this work with funds from greenhouse gas emission cap and trade auctions, financing offers from green banks, and incentives from state housing finance agencies. Utility regulators can affect a project's feasibility through decisions regarding customer rate structures. Finally, some local municipalities assist with grants, property assessed clean energy (PACE) financing, and technical support.

### *EXAMPLES OF EXISTING PROJECTS AND PROGRAMS*

We highlight two program approaches that encourage the integration of energy efficiency and solar resources in affordable multifamily buildings. To our knowledge, California's Low-Income Weatherization Program for Multifamily Properties (LIWP-MF) is the only state affordable-multifamily energy efficiency and solar program that requires participants to improve the energy efficiency of their building before adding solar. The program also supports a whole-building approach by offering owners large incentives to make investments that reduce tenant energy use and costs while providing comprehensive technical assistance. The Connecticut Green Bank's multifamily program provides loan products that can be used to cover the cost of project predevelopment, implementation, and energy performance monitoring work. Green Bank staff attribute their success to close coordination with the state's government agencies, utilities, and CDFIs.

We also profile the work of two affordable housing providers to better understand how programs can support projects that involve both energy efficiency and solar technologies. The National Housing Trust Enterprise Preservation Corporation (NHT-Enterprise) is a nonprofit affordable multifamily housing developer and lender. NHT-Enterprise has installed energy efficiency and rooftop solar systems across several properties using a portfolio-based approach. The organization formed a separate solar developer, NHT Renewable, to oversee the installation of solar systems across multiple properties as part of a single project. This approach not only reduces project predevelopment costs, but also attracts more investors because it increases the project's scale. Foundation Communities is an affordable housing provider with more than 10 years' experience overseeing projects that integrate both energy efficiency and solar resources in their multifamily buildings. The belief that sustainable and affordable housing has the power to improve the financial and social welfare of many low-income families and individuals drives these projects.

### *COMMON APPROACHES*

The projects we examined had several things in common. All building owners installed energy efficiency upgrades before rooftop solar systems and prioritized obtaining utility-sector incentives for these measures to improve financial feasibility. Even though solar system installations did not always occur near the time of a major building capital event such as a renovation or refinancing, project managers prioritized the inclusion of energy efficiency upgrades alongside photovoltaic (PV) equipment.

Several housing providers expressed concern with the performance of newer energy efficiency and solar technologies such as solar systems or energy-efficient heating and cooling equipment. They suggested that performance issues could be related to the design or installation of the equipment, but they also proposed that these issues could stem from building operation issues. Interviewee responses mirrored previous research findings that many building operators have not been trained to properly operate, maintain, and monitor newer energy efficiency and solar technologies.

Owners sought to install energy efficiency and solar systems across multiple buildings in their housing portfolio at once to save on project predevelopment costs. They worked to educate building residents on the installation, use, and benefits of these improvements. However housing providers have found it difficult to invest in energy efficiency and solar

projects that financially benefit tenants who are responsible for their own utility costs. This is a common market barrier to energy efficiency because such investments have little guarantee of a financial return for owners. Utility allowance adjustments can help provide an incentive for such projects, but only under specific circumstances.

### *RECOMMENDATIONS*

Drawing on our research, we make several recommendations to increase investments in both energy efficiency and solar projects for affordable multifamily buildings. These recommendations also increase the value these projects offer for energy efficiency program administrators, potential investors, and affordable multifamily building owners, residents, and staff. We recommend that efficiency and solar program administrators

- Offer solar incentives to affordable multifamily owners with the condition that applicants also install energy efficiency upgrades
- Designate program staff who will serve as the primary point of contact for applicants wishing to take advantage of efficiency, solar, and water conservation program offerings
- Provide increased funding for structural, health, and safety building upgrades
- Fund project predevelopment work or provide staff to assist with project planning
- Encourage energy efficiency contractors, solar installers, and energy auditors to work collaboratively
- Require that program participants use energy benchmarking services and software
- Educate tenants about the installation, use, and benefits of a building's energy efficient equipment and solar systems, and encourage energy-efficient behavior
- Provide large incentives or financing for owners to reduce renters' energy use
- In collaboration with manufacturers and trade associations, train building operators to operate, maintain, and monitor newer energy-efficient and solar technologies

In addition, we recommend that housing finance agencies adopt utility allowance adjustment methods that will encourage investments in energy efficiency and solar resources. Opportunities also exist for lenders to create more loan products that can be used to specifically finance energy efficiency and solar projects in affordable multifamily buildings.

Finally, state and local policymakers should take steps to grow the workforce of highly trained building operators. We recommend adopting policies that require or incentivize building owners to pursue energy efficiency and solar investments. This increases the value of building operators' work. They should also work with local or regional stakeholders to identify building operator job opportunities and the specific training that building and construction industry workers will need to fill those positions. Finally, policymakers should provide funding for community colleges, universities, and union apprenticeship programs to expand the number of students and instructors participating in courses focused on high-performance building operations, or direct that instructors integrate a high-performance building curriculum in existing relevant coursework.

## Introduction

Policymakers, advocates, and community-based groups across the United States are working to relieve communities of color and low-income communities of the inequitable burdens associated with the production, consumption, and costs of energy. With few options for affordable housing, these individuals and families are more likely to live within the direct vicinity of power plants that emit pollutants (Davis 2010; Massetti et al. 2017; Mikati et al. 2018). They also tend to reside in homes that are aging, energy inefficient, and in need of repair. Residents of homes that are not energy efficient can suffer exposure to poor indoor air quality and tend to have higher energy costs (Norton et al. 2016). Drehobl and Ross (2016) found that low-income households spend on average up to three times as much of their income on energy bills as higher-income households. These costs fluctuate from month to month. Utility expenses rise when rates go up and during peak heating or cooling months. These sudden increases can lead low-income families and individuals to fall behind on utility, housing, health-care, food, or child-care expenses (Desmond 2016; Franklin et al. 2017).

Remedying the problems these communities face requires substantial investment and innovative policy strategies. To that end, some policymakers are deploying multiple energy resources to reduce low-income households' utility expenses and their exposure to pollution from energy generation. Under the direction of state lawmakers and regulators, some utilities have created energy efficiency programs that reduce the energy burdens faced by their low-income customers. Drehobl and Castro-Alvarez (2017) found that these programs are widespread and currently serve 49 of the 51 largest metropolitan areas. However most have limited resources. Administrators must decide between providing a small set of efficiency upgrades to many households and providing more services to fewer (Gilleo, Nowak, and Drehobl 2017).

Solar incentive programs for low-income and disadvantaged communities have been slower to develop, but this is beginning to change. The solar photovoltaic (PV) market has grown rapidly in recent years as costs for these systems have dropped dramatically (Fu et al. 2017). Utilities, businesses, and single-family homeowners have been at the forefront of investing in solar PV (Perea et al. 2017). Multifamily housing has been generally overlooked, especially apartment buildings that rent to low-income households (Inskeep, Daniel, and Proudlove 2015; Garren et al. 2017).

Owners of affordable multifamily buildings have long encountered challenges in their attempts to reduce low-income residents' energy burdens. Many housing providers cannot afford to dedicate substantial staff time to planning energy efficiency and solar projects, have trouble obtaining financing for such work, lack building staff experienced with newer energy efficiency and solar technologies, and receive little to no return on investments that reduce renters' energy bills. Even with these challenges, some affordable multifamily owners find that both rooftop solar systems and energy efficiency upgrades can be sensible

investments with the right mix of economic and policy incentives.[1] These housing providers are aware that many of their older buildings are inefficient. Two-thirds of multifamily dwellings were built before the advent of energy codes and tend to have many structural inefficiencies that can lead to higher-than-expected utility expenses and decreased cash flow (Henderson 2015). Garren et al. (2017, 43) point out that "utility bills are usually the largest and most volatile portion of an affordable housing development's budget . . . . [S]tabilizing utility bills through solar and other measures makes it easier to maintain operating budgets, retain tenant services and avoid raising rents."

Few researchers have examined how affordable multifamily buildings can effectively incorporate both energy efficiency and solar resources to achieve high energy savings and other benefits for owners and residents. No comprehensive research or database of these projects exists, making it difficult to determine how many occur or how frequently. Because much about these projects remains unknown, we have chosen to examine several case studies of projects and programs that have successfully combined energy efficiency upgrades and rooftop solar systems in affordable multifamily buildings. Our objective is to understand more about the overall approaches and motivations of the program administrators, investors, building owners, and real estate developers leading these projects.

## Methodology

Over the course of several weeks, we conducted semi-structured interviews with professionals from ten organizations. These included staff from four programs, two housing providers, and two energy service companies (ESCOs) that work to integrate both energy efficiency and solar resources in affordable multifamily buildings.[2] Unless otherwise stated, any information included in this report regarding specific projects or programs is drawn from these interviews and documents or data provided by interviewees. We selected interview participants using convenience sampling.[3] Members of the Network for Energy, Water, and Health in Affordable Buildings (NEWHAB) and American Council for an Energy-Efficient Economy (ACEEE) staff provided recommendations and contact information for interviews. We also conducted background research on the policies that have most affected the work.

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[1] For purposes of the report, 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.

[2] We conducted interviews with the Association for Energy Affordability, Connecticut Green Bank, Spark Northwest, Emerald Cities Seattle, Fort Collins Utilities, Rocky Mountain Institute, National Housing Trust, Foundation Communities, ICAST, and Affordable Community Energy Services. Spark Northwest and Emerald Cities Seattle work together on a joint program. Fort Collins Utilities and Rocky Mountain Institute also work on a joint program. We have not attributed specific comments to any one interview participant without their approval.

[3] Convenience sampling is a kind of nonprobability sampling that collects data from sources according to ease of availability.

Because our research uses convenience sampling, we do not consider projects examined for this report to be representative of all affordable multifamily energy efficiency and solar projects. However we have made every effort to analyze a diverse sample of case studies. We include the perspectives of multiple project decision makers and examine projects and programs from various regions of the country. Our interviews included questions about planning, goals, funding sources, and lessons learned. Where available, interviewees were asked to share quantitative data regarding project characteristics, costs, and outcomes. We have profiled the work of those organizations that provided detailed descriptions and performance metrics for projects involving both energy efficiency and solar resources.

## Background

### *MOTIVATIONS FOR INTEGRATING ENERGY EFFICIENCY AND SOLAR RESOURCES IN AFFORDABLE MULTIFAMILY BUILDINGS*

Affordable multifamily owners' motivations for investing in energy efficiency and solar resources are like those driving many single-family homeowners. Affordable housing providers want to lower their utility costs and, if possible, those of their residents. Reducing these costs increases an owner's net operating income (NOI) from a building.[4] This increases a property's value.[5] While a nonprofit affordable multifamily housing provider may not quickly sell a building, increases in property value are important to expand borrowing capacity. Owners that reduce utility expenses and increase NOI can ultimately improve their access to capital for the renovation, acquisition, and construction of affordable housing units.

Affordable housing providers we interviewed noted that the desire to improve the environment also motivated them to pursue energy efficiency and solar projects. Affordable housing and sustainability are complementary goals. Building owners invest in solar to participate in green power markets that reduce pollution and improve the long-term health and well-being of low-income families. Some providers noted in interviews that they are "forever owners" of properties and therefore able to make what are typically referred to as *patient investments* that have longer paybacks. With patient investing, owners do not realize quick returns, but they may be able to make building improvements that reduce a low-income community's health risks from environmental degradation and a changing climate.

Long-term energy efficiency and solar investments can also increase a building's resilience (i.e., the ability to bounce back from or endure both gradual and abrupt environmental changes or electricity outages). If heating, ventilation, and air-conditioning (HVAC) systems become inoperable due to service outages, well-insulated, weatherized residential buildings can maintain livable indoor conditions longer than inefficient ones—whether during cold or hot weather (York, Baatz, and Ribeiro 2016). Solar PV can shield owners from the risks

[4] A building owner's net operating income (NOI) is the revenue that remains from rents and other income after accounting for all associated operating expenses and debt service.

[5] Property values are calculated by dividing a building's 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).

associated with nonrenewable energy generation. It can benefit housing providers by hedging against fossil fuel price increases and associated rate increases and volatility. Solar systems may also be used to deliver electricity in the case of power outages, if appropriate regulatory mechanisms are in place to enable the installation of battery back-up systems (Waite and Mullendore 2017).[6]

For affordable housing developers, owners, and investors we interviewed, energy efficiency added to the potential benefits of a solar project. Those we spoke with have come to expect that combining energy efficiency with solar systems will increase a housing provider's ability to preserve and expand affordable housing by reducing utility use, operation, and maintenance costs. They also anticipate that the combination of the two resources will reduce more local and global negative environmental impacts while providing positive returns for investors.

Integrating energy efficiency in buildings along with solar PV systems is critical to reduce a property's total energy demand. By decreasing such demand, the size and attendant cost of PV systems can further be reduced, lowering the investment hurdle faced by building owners. The net result is a more affordable package of energy efficiency and solar technologies for property owners and residents. Housing providers and investors that 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, one ESCO we interviewed commented that, by taking a "whole tree" approach to energy efficiency retrofits and adding solar, they could leverage the utility cost savings from measures with faster paybacks to help pay for those with longer paybacks.

### *POLICY ENVIRONMENT FOR INTEGRATED ENERGY EFFICIENCY AND SOLAR PROJECTS*

Affordable multifamily projects that integrate both energy efficiency and solar resources have occurred sporadically throughout the United States. We found only a few cities and states where these projects are being completed, and their success has been highly dependent on supportive policies and regulation. 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.

Public perceptions of the costs and benefits of energy efficiency compared to solar resources may pose a challenge for adopting policies that encourage the deployment of both resources. From a customer perspective, the economics of solar-generated electricity may be easier to understand as customers receive credit for electricity that can be directly metered. Reduced energy costs that result from improved energy efficiency may be less tangible or visible. Consequently policies targeting renewable energy may garner more attention than those supporting energy efficiency upgrades.

We identify four key policy areas that can support and drive the market for integrated energy efficiency and solar in affordable multifamily housing:

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[6] Most installed PV systems do not include such systems due to their additional cost and complexity.

- Federal policies and incentives
- State policies and incentives
- Local policies and incentives
- Utility regulation

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) is a critical subsidy for solar installations, and all interviewees stated that it was an important source of project funds. Many of the affordable multifamily housing providers featured in this report are nonprofit organizations, so they do not have taxable income.[7] To benefit from the ITC, they must either identify an equity investor with taxable income that can monetize the credit's value or arrange for a third-party company to own the solar system. The federal ITC has been an important source of funding for projects, but it is unclear how effective it will be in the future. While in recent 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 (Garren et al. 2017). In reducing the tax burden, the lower federal corporate tax rates enacted in 2018 may also lower companies' use for the ITC.

The Community Reinvestment Act (CRA) has also played a role in providing financial support for energy efficiency and solar projects. Congress passed the CRA in 1977 to ensure that banks invest in low-income and minority communities. Before passage of the CRA, many banks would "redline" certain communities and refuse to invest in them. In 2016, three regulatory agencies responsible for overseeing CRA compliance issued guidelines stating that lending for energy efficiency and solar projects in affordable housing would be assessed favorably on CRA reviews (NLIHC 2017). Speer (2012) explains that most banks will still not finance residential energy efficiency and solar projects because they are viewed as risky and too small in scale. However many banks will lend to community development finance institutions (CDFIs) to make such investments on their behalf. CDFIs are private financial institutions that operate with the explicit mission of making investments that will benefit underserved people and communities. CDFIs will often pair this funding with that from other sources to finance energy efficiency and solar projects in affordable housing.

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 has anticipated

[7] While all the projects featured in this report are nonprofits, some for-profit companies also participate in available programs for integrated energy efficiency and solar in affordable housing. For example, many of the projects in California's Low-Income Weatherization Program (LIWP) are owned by for-profit companies.

that such a reduction will lead owners to "adopt higher standards for construction, rehabilitation, repairs, maintenance, and property operations that are more energy efficient and sustainable than traditional approaches to such activities" (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

State legislation and government initiatives can also play a major role in fostering markets that support energy efficiency and solar installations in affordable multifamily housing. States with both an energy efficiency resource standard (EERS) and a renewable electricity standard (RES) or renewable portfolio standard (RPS) are more likely to support programs that incentivize the use of both 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 targets by purchasing renewable energy credits (RECs) created by private market solar projects (Garren et al. 2017). These goals have encouraged utilities and private investors to fund solar projects. Twenty-five states currently have both an EERS and an RES or RPS (ACEEE 2017a; Durkay 2017). However adoption of both policies is no guarantee that utilities will coordinate their efficiency and solar funding or target affordable multifamily building customers.

States such as California are using funds from greenhouse gas emission cap and trade auctions to fund programs that incentivize multiple energy efficiency and solar resources, provided they are used to meet specific environmental goals. California Assembly Bill 398 requires that auction proceeds be used to reduce air pollution, support clean energy technologies, and improve environmental quality (California Assembly 2017). California has also passed legislation (Senate Bill 535) requiring that at least 25% of auction revenue be used for programs targeting disadvantaged communities (California Senate 2012). One of the interviewees from California's Low-Income Weatherization Program for Multifamily Properties (LIWP-MF) stated that the flexibility afforded to programs in using auction funding and the carve-out for disadvantaged communities has enabled their program to be successful.

California's history of legislative and regulatory actions to support solar energy in affordable multifamily housing demonstrates a strong and sustained commitment to renewables. Policymakers have also made gradual strides to integrate energy efficiency requirements and funding into these programs. We provide additional details on how California's programs serving the affordable multifamily market support both energy efficiency and solar resources in our discussion of the LIWP-MF that follows.

State and local governments can also create green banks to support the integration of 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). Connecticut has created a green bank that provides low-cost financing to support building projects, including affordable multifamily housing, that integrate energy-efficient features with renewable energy systems. An expert we interviewed commented that Connecticut's approach is "technology agnostic," with financial products available to fund either energy efficiency or solar. The focus is on achieving the highest-value return on investment while increasing the health, durability, and affordability of multifamily buildings. We provide additional details on the Connecticut Green Bank below.

To encourage investments that reduce renters' energy use, some state housing finance agencies (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, although this can vary slightly across programs or administrators. To do this in a building regulated by an HFA, owners reduce rents to compensate for tenants' expected utility costs. These adjustments are referred to as *utility allowances*. When renters' utility costs decrease, building owners in certain states can use energy consumption modeling or actual tenant utility consumption data to recalculate utility allowances and increase rents (US Code 2016). This increases the owners' cash flow and provides them with a return on their investment.

Bartolomei (2017) points out that most HFAs have formally authorized owners to use project-specific utility allowances, and two states have taken steps to actively encourage owners to do so. In 2014, Arizona's HFA required that all new Low-Income Housing Tax Credit (LIHTC) projects use these methods to calculate utility allowances. When scoring a project, Washington's HFA provides LIHTC applicants with additional points for using an energy consumption model.

Utility allowance adjustments are not always practical, and several preconditions must exist for owners to use them (Bartolomei 2017). Utilities will need to provide property owners with whole-building energy use data to adjust allowances using what is referred to as an actual tenant consumption data method. HFAs wishing to offer owners the option of using an energy consumption model to make adjustments will need to ensure that a highly reliable and accurate model is accessible and that affordable qualified professionals are available to conduct the analysis. Finally, some owners may be unable to increase rents due to soft market conditions. Some may also be using a very low utility allowance relative to their actual energy costs, and adjustments would at best lead to only a marginal increase in their cash flow (Waite and Associates and National Housing Law Project 2017).[8]

HFAs can also incentivize 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

[8] For further information on utility allowances see nhlp.org/initiatives/energy-efficiency-renewables-and-utility-allowances/.

often than for other types of sustainability improvements in buildings. Twenty-eight state plans awarded points for both energy efficiency and solar in 2017.

### Local Policies and Incentives

Local governments can also use policies and incentives to support the integration of renewable energy and energy efficiency upgrades in affordable multifamily housing. Some local governments provide commercial property assessed clean energy (C-PACE) financing as an option to fund both energy efficiency upgrades and solar systems in commercial and multifamily buildings.[9] While C-PACE terms are like those of a loan, repayments are made as part of a property owner's local taxes (Gilleo, Stickles, and Kramer 2016). However the multifamily sector has been slow to adopt this approach. Adamczyk et al. (2018) found that very few affordable multifamily projects have been completed because affordable-multifamily deals are complex for PACE administrators, few technical support resources are available for building owners and managers, some building owners place a lower priority on saving energy, and C-PACE financing is often not competitive with other loan products. C-PACE providers also typically concentrate on either solar or energy efficiency projects, but not both. This may be because administrating staff lack expertise in both (S. Morgan, president, Clean Energy Solutions, pers. comm., February 20, 2018).

While all interviewees placed a high value on energy savings, several commented that they had not witnessed many projects using C-PACE as the interest rates have not been competitive with other available options. Although limited in number, some affordable multifamily housing projects have used C-PACE to finance energy efficiency upgrades and solar systems. For example, the Phyllis Wheatly YWCA in Washington, DC, used $700,000 in PACE financing to install both energy efficiency upgrades and a 30 kW solar system as part of a $17 million renovation to preserve the building's 84 low-income rental units (DC PACE 2017). This suggests that C-PACE may be an effective financing tool for these projects under certain conditions.

Ribeiro et al. (2017) found that city sustainability and climate plans are increasingly including goals to reduce the energy use of low-income households. These can lead cities to fund initiatives that support the installation of energy efficiency and solar resources in affordable multifamily buildings. Interviewees stated that local governments had supported their work with grants, low-interest financing, or other support. They also stressed that it can be challenging to obtain these funds when the city departments administering them do not coordinate with one another or with other locally available energy efficiency and solar programs.

We highlight Seattle, Austin, and Washington, DC, as examples of cities working to increase the deployment of energy efficiency and solar resources in affordable multifamily housing. Each of these cities operates its own municipal or sustainable energy utility. This can be an advantage in developing and providing programs and services tailored to meet the unique needs of affordable housing within their respective communities. The local scale of these

[9] A local government is only able to fund a C-PACE program in states that have adopted enabling legislation (Gilleo, Stickles, and Kramer 2016).

utilities may allow for a more focused, responsive approach than those by utilities serving large service territories with many cities of varying sizes that include rural and suburban areas. Another advantage can be that local municipal and sustainable energy utilities are typically regulated by local governments, boards, or similar authorities rather than by state public utility commissions. This can facilitate the development of policies and programs best suited to local needs and resources (Houck and Rickerson 2009; APPA 2016). We discuss additional aspects of utility regulation in the following section.

### Utility Regulations and Policies

Utility regulation plays a pivotal role in supporting both energy efficiency programs and distributed energy generation such as solar PV. Numerous aspects of utility regulation affect the viability and strength of programs and services for affordable housing projects integrating energy efficiency with renewable energy, including

- Customer incentives
- Rates and rate structures
- Distributed generation policies
- Customer equity[10]

Customer incentives and services from utility energy efficiency and solar programs support projects reducing affordable housing energy costs. All interviewees stated that incentive payments to property owners for qualified energy efficiency measures or solar equipment are a critical component of the overall funding bundle needed for a project to move ahead. Technical assistance from programs can also be important to multifamily property owners in facilitating projects. As we have noted, state policies are the primary drivers for the creation of these programs, but utility regulators largely determine programs' incentive structures, requirements, and funding. Typically, utility-administered programs directly provide such incentives, but some nonutility programs provide similar incentives and services. In our examples, the District of Columbia Sustainable Energy Utility is such a nonutility program (funded via utility rates).

The economics of solar projects are strongly a function of utility electricity rates and rate structures. Electricity rates are a primary determinant of the returns on solar investments—the "payback period" as viewed by many property owners. Customers that pay higher rates tend to spend more on their electricity bills and have greater motivation to invest in energy efficiency and solar improvements. Rates and rate structures are undergoing significant changes in many areas. Some utilities have increased fixed monthly charges while reducing the volumetric (variable) charges for electricity. Time-of-use (TOU) rates also are being enacted by a growing number of utilities as they roll out "advanced metering infrastructure" (AMI)—commonly referred to as *smart meters*. Such changes in both the magnitude of rates and their structure will have significant impacts on the economics of

[10] Utility regulation takes different forms, depending on the type of ownership: (1) investor-owned, (2) municipal, or (3) cooperative. State public utility commissions regulate investor-owned utilities. Municipal governments regulate municipal utilities. Elected boards regulate cooperative utilities. The objectives and motivations vary among these types. Such differences can affect funding and services provided to affordable housing markets.

customers' willingness to reduce energy use (Baatz 2017). For example, higher fixed charges and lower volumetric charges will increase paybacks for energy efficiency and solar projects.

Net energy metering (NEM) is closely related to issues of electricity rates and rate structures. Aznar (2017) explains that NEM is a metering and billing arrangement to compensate owners of solar or other distributed generation for electricity that is exported to the grid. NEM policies vary widely across the 44 states (and DC) where they have been instituted. Some NEM policies are supportive of distributed generation while others may hinder such developments. The issues surrounding NEM are complex. For multifamily buildings, NEM is only relevant for owners who pay for all electricity use in a building. Otherwise virtual net energy metering (VNEM) would be applicable. VNEM is a means to allocate revenues from a common solar system among residents who virtually share in the system's benefits. Customers tend to care most about the cost savings and possible income received from solar generation.

Related distributed generation policies also play a large role in determining the market climate 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 a distributed energy provider.

Customer equity is another concern for utility regulators. ACEEE (2017c) found that guaranteeing equity among customer classes can be a motivation for regulators to assure that limited-income customers are served through utility energy efficiency and renewable energy programs. To this end, regulators may establish service requirements and oblige utilities to fund and provide energy efficiency and renewable energy programs that target and serve limited-income customers, giving them access to solar resources. Utility regulators also can facilitate programs by allowing low-income renters access to on-bill financing for major energy efficiency upgrades and renewable energy systems (ACEEE 2017b). These measures also help address equity concerns in terms of energy burdens faced by limited-income households.

Utility regulators have a large influence on the measures that can be offered in customer energy efficiency programs by establishing the tests and associated criteria for determining their cost effectiveness. Many utility commissions recognize that programs and incentives that serve the affordable housing market may have difficulty meeting cost-effectiveness tests used for other types of customers and markets. This may be due to the higher costs of serving low-income households and the need to pay larger incentives in some cases because of the more limited ability of such households to share costs of improvements. Thus commissions may set lower thresholds for cost effectiveness for programs serving affordable housing markets (Gilleo, Nowak, and Drehobl 2017).

## Examples of Existing Projects and Programs

The following programs and projects provide a glimpse of the kinds of support that affordable multifamily housing providers need to successfully integrate energy efficiency and solar resources into their buildings. We have highlighted these organizations because

they provided us with detailed data characterizing the outcomes of integrating both energy efficiency and solar resources in buildings.

### *CALIFORNIA'S AFFORDABLE SOLAR AND LOW-INCOME WEATHERIZATION PROGRAMS*

#### Approaches to Affordable Multifamily Solar Programs

The California Public Utilities Commission (CPUC) collaborated with the California Energy Commission to establish the California Solar Initiative (CSI) in 2006. CSI was designed to fund solar installation rebates for qualifying customers of the state's three largest investor-owned electric utilities (CPUC 2006). California Assembly Bill 217 funded the initiative with a surcharge applied to customers' bills (California Assembly 2013). California's legislature required that 10% of the total funds committed to this initiative--$2.5 billion over 10 years—be used for solar installations on low-income residential housing. A subsequent decision in 2008 allocated $108 million of these funds to form the Multifamily Affordable Solar Housing (MASH) program. The CPUC directed participating utilities to file tariffs for a virtual net metering program so electricity produced by one multifamily solar installation could benefit renters in the form of utility bill credits (CPUC 2008). While MASH provided higher incentives for systems benefiting tenants, it did not require owners to offset renters' energy use with solar.

Building on this initiative, California passed Assembly Bill 693 in 2015 to create a Multifamily Affordable Housing Solar Roofs Program (MAHSRP) (California Assembly 2015). Legislators directed the state's investor-owned utilities to use up to $100 million of their greenhouse gas auction revenues to provide the program with annual funding. In implementing this directive in 2017, the CPUC renamed MAHSRP the Solar on Multifamily Affordable Housing (SOMAH) program. SOMAH is slated to launch in 2018. Succeeding the MASH program, SOMAH will provide incentives for the installation of rooftop solar systems on existing multifamily affordable housing. In addition to having more funding than MASH, SOMAH will require that more than 50% of a system's bill credits accrue to building residents. The program also has different funding rules and eligibility requirements than MASH (CPUC 2017).

The MASH program does not require participants to make energy efficiency upgrades to receive solar incentives, but it does require applicants to undergo an online energy efficiency audit and make tenants aware of California's Energy Savings Assistance Program. A 2015 program evaluation conducted by Navigant Consulting revealed that only one-third of participating property owners made energy efficiency upgrades to their buildings, but these actions were not a consequence of the MASH program's approach to energy efficiency (Navigant Consulting 2015). These upgrades were made because owners had previously conducted energy efficiency audits on their own or had participated in one of the state's energy efficiency programs. Evaluators also reported that just 30% of tenants in MASH properties were aware of utility energy efficiency offerings and only 18% received them. The MASH program does not track energy savings from efficiency upgrades because it does not require these improvements. Thus it is difficult to know whether the efficiency upgrades had any bearing on the size of a project's rooftop solar system. SOMAH will be required to institute energy efficiency requirements that are at least as stringent as MASH, and it is unclear whether the program will also take the step of requiring efficiency upgrades (CPUC 2017).

### Low-Income Weatherization Program for Multifamily Properties (LIWP-MF)

While utility-administered solar programs do not require energy efficiency upgrades, California's LIWP-MF obligates participants to reduce energy use with efficiency measures before installing a solar system.[11] LIWP-MF is administered by the state's Department of Community Services and Development (CSD), with implementation led by the Association for Energy Affordability (AEA) and supported by GRID Alternatives, the California Housing Partnership (CHPC), and TRC Companies.[12] 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.

Because the program is funded from California's cap-and-trade program, incentives are based on a project's targeted reduction in greenhouse gas emissions (California CSD 2016). 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 from 50% to 100% of a rooftop solar system's cost and are dependent on 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, and these are covered at 100% of cost. Because of these generous incentives, LIWP-MF has been highly effective in encouraging projects that reduce renters' energy costs.

LIWP-MF staff work across multiple organizations to ensure that projects undergo a thorough application process (California CSD 2016). The CHPC has been a critical partner in recruiting program participants from its affordable housing programs. After completing an interest form, applicants work with CHPC to determine a project's eligibility for the program. CHPC staff ensure that applicants meet the program's housing affordability requirements and have the capacity and funding to complete a project on schedule. Staff from AEA then ask applicants to make a good faith deposit to show their intent to proceed and work with an auditor to project potential energy savings from energy efficiency upgrades. GRID Alternatives is responsible for evaluating a property's solar generation potential. At this early stage, many applicants will also work with AEA to identify utility-sector energy efficiency incentives that can be used to help fund upgrades. AEA or one of its partner organizations, such as TRC, implements most of California's comprehensive multifamily energy efficiency programs. This allows staff to easily layer the incentives from one program with another. After preliminary evaluation work is complete, AEA finalizes the project's scope of work and reserve incentives. The property owner's contractors begin work, and program staff conduct inspections midway through construction and at project completion. Once the project is complete, applicants receive their initial deposit and all

[11] For more information on LIWP-MF see camultifamilyenergyefficiency.org.

[12] 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.

reserved incentives. As of 2017, 6 multifamily properties with 423 units had been approved for both energy efficiency and rooftop solar incentives.

The program's incentive structure and supportive application process have been highly effective at attracting program participants, but this high demand has posed a challenge for program administrators. Many applicants have been wait-listed because demand has outpaced funding, which varies from year to year. The program can only serve a limited portion of the affordable multifamily housing market because its funding can be unpredictable and because some applicants have difficulty covering the upfront costs of projects.

Program incentives cover roughly 70% of most LIWP-MF project costs, but these funds are not awarded until all work is completed. Thus the only applicants selected to participate in the program 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 efficiency and solar projects can be a challenge for participants. To assist with larger projects, program staff have divided the job into phases so incentives can be awarded periodically throughout the course of work.

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 (California CSD 2017). Rooftop solar systems and efficiency improvements each 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. LIWP-MF's combined energy efficiency and solar projects are realizing average annual reductions per household of 1.1 Mt $CO_2e$, 2,456 kWh of electricity, and 54 therms of natural gas. By comparison, a national review of low-income multifamily energy efficiency programs in the 51 largest metropolitan areas found average savings of 1,067 kWh per household (Drehobl and Castro-Alvarez 2017).

### *NATIONAL HOUSING TRUST ENTERPRISE PRESERVATION CORPORATION AND ST. DENNIS APARTMENTS, WASHINGTON, DC*

The National Housing Trust Enterprise Preservation Corporation (NHT-Enterprise) works to preserve, improve, and maintain affordable housing throughout the United States (DOE 2017a).[13] In its role 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.

Like affordable housing developers participating in LIWP-MF in California, NHT-Enterprise faces challenges in 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, and it must decide how to prioritize energy efficiency and solar projects given

[13] For more information see nationalhousingtrust.org.

other building needs. Solar and energy efficiency incentive programs can complicate this decision making with short timelines that leave the organization little flexibility to use its funding. To help address this challenge, NHT-Enterprise leaders 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 buildings. Predevelopment work involves assessing the scope, feasibility, and financing for a project. This project phase is not only costly but also risky for investors because there is still uncertainty that a project will proceed to completion.

NHT-Enterprise has focused on completing energy efficiency and solar projects in locations with the most favorable policies, programs, and electricity rates. The District of Columbia Sustainable Energy Utility (DCSEU), operated by the Vermont Energy Investment Corporation (VEIC), has helped facilitate the installation of rooftop solar systems across several NHT-Enterprise DC properties (DCSEU 2016). In the past, DCSEU has also installed no-cost energy efficiency measures and provided prescriptive rebates for many affordable multifamily projects such as these (Samarripas, York, and Ross 2017). Starting in 2018, low-income multifamily customers will be offered incentives through DCSEU's $2 million competitive performance-based Income Qualified Efficiency Fund. Project selection will be based on the inclusion of local contractors, projected annual energy savings per dollar of investment, matching funds acquired, the scale of innovation, and the number of vulnerable residents assisted (DCSEU 2018).

Site design and building equipment also play a key role in determining which buildings are suitable for an energy efficiency and rooftop solar project. Depending on the design of a building, it can be difficult to find space for both HVAC and solar PV equipment. Green roof requirements, such as those in Washington, DC, have also limited space for equipment. NHT Renewable's portfolio approach to rooftop solar allows for smaller installations on some buildings. While these smaller systems will generate more modest bill credits, these savings can be combined with those from larger systems on other properties. This portfolio approach, along with energy efficiency upgrades, allowed a smaller rooftop solar system to be installed on St. Dennis Apartments, seen in figure 1.

Figure 1. Roof of St. Dennis Apartments in Washington, DC

St. Dennis Apartments was one of NHT-Enterprise's first projects in Washington, DC to integrate both efficiency and solar resources. St. Dennis Apartments is a 32-unit affordable multifamily building that was in disrepair and nearly vacant prior to NHT acquiring it. In an attempt to sell the property, the

building's previous property owners deferred maintenance and illegally raised rents to encourage residents to leave (Moreno 2008). Eva Martinez and her two daughters remained the building's sole residents for two and a half years after all other residents had moved out. Under District of Columbia law, tenants are afforded the right of first refusal for sale of their property to a third party (District of Columbia 1981). Because of this, the Martinez family was ultimately able to secure a contract to buy the building in a settlement with the property's owners. NHT-Enterprise then provided the funding needed to acquire the building. The organization would later install several health and safety improvements, energy efficiency upgrades, water conservation measures, and a 250 kW rooftop solar system. Energy efficiency and water conservation measures accounted for roughly 15% of the project's $10.2 million rehabilitation budget. These measures were added because the building received public financing and was therefore required to adhere to the District of Columbia Green Building Act of 2006. To help defray the cost of compliance, the project relied on a Green Communities grant from Enterprise Community Partners (Enterprise Community Partners 2016). Energy efficiency and water conservation upgrades were completed in 2011, and a solar system was installed in 2014.

Today the building stands fully occupied, and apartment unit utility costs have been reduced by roughly 40% compared to when it was previously inhabited. Because the rehabilitation project was financed using LIHTC and residents pay for their own electricity, this reduction in utility expenses has allowed the owner to set higher, but still affordable, rents under utility allowance regulations established by the District of Columbia's Department of Housing and Community Development (DHCD 2009, 2012). 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. Property value increases such as these have allowed the NHT-Enterprise to raise its borrowing capacity with lenders and preserve more affordable housing units.

### *CONNECTICUT GREEN BANK AND PLAZA ON THE GREEN, WATERBURY CT*

The Connecticut Green Bank provides affordable multifamily building owners with financing for both energy efficiency upgrades and rooftop solar installations.[14] As of 2017, the Green Bank had invested in 26 multifamily projects combining energy efficiency upgrades and solar systems (BlumShapiro 2017). Owners use the cost savings from energy efficiency and solar resources to cover debt issued by the Green Bank. To accomplish this, the Green Bank works in close coordination with energy efficiency initiatives led by state agencies and utilities. A peer-to-peer network of affordable multifamily housing providers helps direct program planning and implementation. Program administrators consult with New Ecology to receive ongoing technical support.

Connecticut's coordinated approach to reducing affordable multifamily energy use was spurred by Governor Dannell Malloy's 2012 proposal to invest $300 million over 10 years to renovate the State-Sponsored Housing Portfolio (RECAP Real Estate Advisors 2014).

[14] For more information see ctgreenbank.com/programs/multifamily/.

Physical needs assessments were conducted for many existing affordable housing properties, but these evaluations did not focus on energy- or water-saving measures. Consequently many such measures were excluded from project scopes due to concerns over their upfront cost. Energy efficiency upgrades were typically included only when installed at no or low cost and were rarely considered as part of a whole-building strategy to save energy over a building's lifetime. Thus energy measures with medium- and longer-term payback periods were "cost engineered" out instead of "value engineered" in. Realizing this missed opportunity, several of the state's energy efficiency and solar programs launched an effort to better coordinate and target their offerings.

The Connecticut Green Bank's financing opportunities are intended to complement available funding from the Connecticut Housing Finance Authority (CHFA), the Connecticut Department of Housing (DOH), and the state's utility energy efficiency programs. CHFA, DOH, and other private lenders generally provide third-party financing for energy efficiency improvements to affordable multifamily properties at the time of a major capital event such as refinancing or renovation. The Green Bank may provide financing solutions for these projects if they need assistance with project predevelopment or the installation of rooftop solar. However the Green Bank tends to focus its efforts on projects that are not seeking CHFA or DOH assistance, meaning projects that do not occur at the time of a major capital event and have capital needs that other sources are unable to provide. Commonly referred to as midcycle retrofits, these projects occur during the operating phase of a building's working capital cycle, as pictured in figure 2. Utility incentives for energy efficiency upgrades or solar installations are factored into all projects.

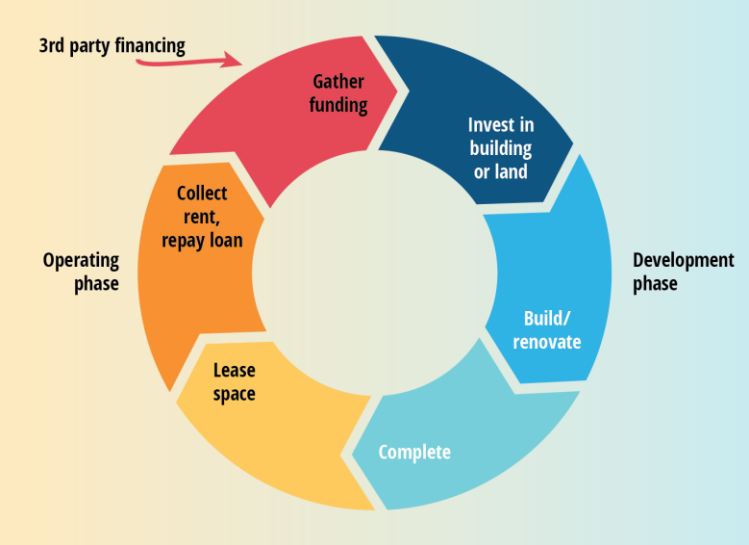


Figure 2. Multifamily building working capital cycle

The Connecticut Green Bank provides unsecured loans to owners of properties serving low-income residents. Thus the Green Bank has 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. 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. Physically and financially distressed properties will seek out Green Bank financing because other lenders are hesitant to issue loans to renovate these buildings. 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 is one example of an affordable multifamily energy efficiency and solar project financed by the Connecticut Green Bank. This 12-story, 157-unit building in Waterbury, CT, keeps rents affordable using subsidies from the federal project-based voucher program.[15] The building's owner, Plaza Green Limited Partnership, a subsidiary of SHP Acquisitions LLC, 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 energy- and water-saving 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, these measures alone 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 in 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 the project with 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 the project with $1.75 million in capital, and the Connecticut Green Bank backed this investment with a loan loss reserve.[16] C4C required that the building owner pay for masonry repairs as a precondition for their investment. The Housing Development Fund (HDF), along with the MacArthur Foundation, provided the remaining needed capital in the form of an $850,000 nonrecourse loan.[17] 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

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[15] The federal project-based voucher program is administered by local public housing authorities (PHAs). A PHA will use its tenant-based voucher funding to cover the rents of low-income families and individuals that agree to live in a preselected private apartment unit. Some units may be set aside for the elderly, those with disabilities, or veterans. Private building owners undergo a competitive application process to participate in the program. Housing subsidies are provided directly to the landlord, and renters typically contribute 30% of their income to rent. For more information see hud.gov/program_offices/public_indian_housing/programs/hcv/project.

[16] *Loan loss reserves* are rainy-day funds that safeguard lenders against the risk that borrowers will 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.org/sector/state-policy/toolkit/loan-loss-reserves.

[17] Nonrecourse loans are those that can only be secured by collateral, usually real property. Lenders cannot hold borrowers personally liable for nonrecourse loans.

benchmarking services company. Because of the Connecticut Green Bank's approach, the building is now anticipated to annually save 71.9 kBtu of source energy and 13.4 gallons of water per square foot.[18] These energy savings mean that the owners now pay only $248,303 in annual utility costs. This translates into a 44% decrease in utility costs and a projected $3.1 million increase in property value.[19]


Figure 3. Plaza on the Green in Waterbury, CT

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. As seen in figure 3, 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. These systems combined cost $1,825,814 and will result in first-year net savings of $191,000. The project's LIME loan requires it to have a first-year energy savings coverage ratio (ESCR) of 1.30, meaning that annual energy cost savings must be 1.3 times greater than the loan's annual debt service. Project soft costs, along with health and safety upgrades, do not directly result in energy cost savings. These expenses totaled $639,700, more than a third of the LIME loan, and reduced the ESCR. Solar PV was excluded specifically because it would have resulted in a lower project ESCR when compared with the natural gas heating equipment.

### *FOUNDATION COMMUNITIES AND ARBOR TERRACE, AUSTIN*

Foundation Communities in Austin is a nonprofit affordable housing provider focused on improving the financial and social welfare of low-income families and individuals.[20] The organization's leadership concentrates on developing multifamily housing that provides

[18] While historical source energy use was not available for comparison, we can report that the building is reducing its annual water use by 31%.

[19] This was calculated using an income approach for determining property value.

[20] For more information see foundcom.org.

residents with affordable rents in environmentally sustainable buildings. Foundation Communities prioritizes energy efficiency and solar improvements for their properties because they benefit the health, well-being, and financial stability of their residents.

While the organization has a goal of constructing buildings that have minimal energy and water use, project managers take different approaches with new construction and existing building projects. New construction housing projects are planned with the goal of saving as much energy as is financially feasible beyond energy code requirements. Project budgets give priority to high-efficiency building systems, and they use the remaining resources 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, Foundation Communities only considers energy efficiency and renewable resources for an existing building if they have a 10-year or less payback. This limit is based on the organization's experience and priorities. Foundation Communities' leadership prioritize being able to continually consider buildings for energy efficiency retrofits or renewables using contemporary technologies. In their experience, energy technologies can easily become outdated over a 10-year period. Property managers also tend to see substantial resident turnover in that span. Foundation Communities highlights each building's green features for tenants and provides them with instructions on how to use the equipment in their unit upon move-in. It is easier to install new equipment and educate tenants who are new to the building as opposed to current residents.

Foundation Communities has been able to continually make substantial investments in the latest energy efficiency and solar technologies because it

- Plans to maintain long-term ownership of buildings
- Cultivates substantial capital reserves
- Takes advantage of local energy efficiency and solar incentives
- Builds strong relationships with several partner organizations and vendors

Foundation Communities describes itself as a "forever owner" of buildings, meaning it does not plan to sell its affordable housing properties. Thus project managers can plan for new construction projects that include energy efficiency and solar 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 incentives provided by Austin Energy, the city's municipal utility, have been 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 dedicated time and resources to establishing 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 surface reflectivity, reduce heat gain, and decrease the building's need for cooling. A 76 kW solar PV system was added to the roof with the capacity to generate 104,366 kWh of electricity annually. Table 1 shows that the building annually uses less energy and water than the national median for multifamily buildings, and this translates into lower utility costs for Foundation Communities, which is responsible for paying energy and water expenses.[21]

**Table 1. Annual whole-property energy and water use**

| Property | kBtu per ft² | Gallons of water per ft² | Utility cost per ft² |
|---|---|---|---|
| National median | 59.6 | 121.0 | $1.58 |
| Arbor Terrace | 41.0 | 27.8 | $1.15 |

Energy use is reported as site energy. *Sources:* Fannie Mae 2014; EPA 2016.

Arbor Terrace earned four out of five stars under Austin Energy's Green Building rating system that recognizes high-performing buildings.

## Challenges and Opportunities

While this report highlights several success stories, project leads we interviewed stressed that they had previously missed program incentives due to conflicting program timelines, challenging project requirements, or a lack of funding or staff to complete predevelopment work. For example, an owner might need to replace a dilapidated roof before installing solar panels. Replacing the roof provides an opportunity to make the building more energy efficient with upgrades to insulation and roofing material. However obtaining funding to replace a roof and soliciting bids for both weatherization and solar contractors may take time. In that time, program requirements and available incentives could change. The following sections further characterize project challenges and discuss opportunities to maximize the benefits afforded to program administrators, building owners, residents, and investors.

### *PROJECT TIMING*

Previous research by McKibbin (2013), Johnson (2013), and Henderson (2015) indicates that a major capital event, such as refinancing or renovating an affordable multifamily building, provides owners with access to needed funding for the upfront cost of efficiency upgrades. Because of this, many energy efficiency programs target owners during these periods. However, while it is true that owners have access to more capital during refinancing or renovation, our research shows that owners will consider energy efficiency and solar investments at all stages of a building's life cycle if provided with a clear rationale and sufficient staff and funding.

[21] We have provided the national median energy use for general comparison only. Comparing a building with the national median has limitations because it is determined after considering buildings of different sizes and climates.

Affordable multifamily building owners who want to install a rooftop solar system often need to consider doing so before or after a major capital event because adding this during a renovation may complicate the project unnecessarily. Rooftop solar installations do not have to occur during a renovation. These systems do not require building upgrades unless a building's roof needs replacement or repair. To add a solar system during a renovation, project staff would need to coordinate the work of a separate team of solar installers alongside other contractors. Installing rooftop solar systems on multiple buildings at once, as NHT Renewable does to manage costs, can also make coordination with renovation contractors impractical. This can increase the length, complexity, and cost of a project.

Building owners and developers who install rooftop solar may pursue whole-building energy efficiency and solar projects at a time other than would be expected by some utility-sector energy efficiency programs, but they are still highly motived to improve the efficiency of their buildings. Affordable housing providers may take advantage of multiple opportunities to make these upgrades. Capital-intensive energy efficiency improvements may be made during the refinancing or renovation of a building, with a rooftop solar system installed soon after these upgrades are complete. Owners may also choose to install a solar system several years after refinancing or renovating a property. In these instances, they may consider additional efficiency upgrades to reduce the need for a larger solar system. Smaller systems are an advantage to owners because they can be funded with less upfront investment and pose less risk to investors should the system fail to perform as expected. All interviewees stated that they installed energy efficiency upgrades in buildings prior to rooftop solar systems and made obtaining utility-sector incentives for these measures a primary project focus.

### *PROJECT FINANCING*

Our research suggests that owners are willing to make energy efficiency and solar investments if they can secure sufficient funding, but those wishing to install rooftop solar systems face limited financing options. Few state and local multifamily solar incentives exist, and those that do tend to operate with short or conflicting application timelines. Furthermore, one interviewee stated that utility bills have not consistently and accurately reflected changes in solar credits and incentives over time. These billing errors have resulted in lower energy cost savings. Last, most lenders are not underwriting energy savings from either solar or energy efficiency projects (McLaughlin 2017). Green banks such as Connecticut's can offer low-cost financing options specifically for energy efficiency and solar resources, but there are few such organizations in the United States.

Many of these projects also encounter challenges in covering the cost of predevelopment work. Obtaining financing for predevelopment work is difficult because this initial work may reveal that energy efficiency and solar measures are not needed or are not cost effective. Adding energy efficiency measures to a solar project or designing a project that benefits tenants adds to these costs.

Because of these challenges, many affordable multifamily housing owners use cash reserves or power purchase agreements (PPAs) to install rooftop solar systems. In entering a PPA, solar companies agree to coordinate and fund all predevelopment, installation, and monitoring of a solar project in exchange for revenue from the solar system. Housing

providers are required to make little or no upfront investment for these projects. Owners will then purchase electricity at a reduced rate from the solar provider and may have the option to purchase the system after several years (EPA 2011).[22] Solar companies may work to achieve economies of scale in agreeing to a PPA and will install rooftop solar across several multifamily buildings in an owner's housing portfolio at once. Accelerated depreciation for installed equipment is also an important component of PPA financing. If owners consent to PPAs with ESCOs, they may be able to use the energy bill savings from solar systems to fund more comprehensive energy efficiency upgrades.

While PPAs are a popular option to install solar on affordable multifamily buildings, some owners can cover the upfront cost of systems with cash reserves if they are assured that substantial local or state incentives are available to recoup at least part of the cost. Solar-specific financing options may be available in certain locations. Some programs also offer no-cost technical support or small loans to help cover project planning expenses. Like solar companies, some housing providers are working to achieve an economy of scale by planning projects that span multiple properties. Owners that take this portfolio-based approach provide efficiency program administrators with an opportunity to incentivize many energy efficiency upgrades across multiple properties at once.

### *BUILDING PERFORMANCE*

Interviewees stated that the most successful projects were those that used highly reliable energy efficiency upgrades to hedge against risks associated with investing in many newer technologies. Our interviewees asserted that the most reliable energy efficiency upgrades were weatherization improvements and those reducing a building's non–heating and cooling energy use. Interviewees also reported installing water conservation measures in many projects because these are associated with reliable utility cost savings. These measures reduce not only water costs but also the energy needed to heat water. Project data reveal that water conservation investments can lead to water savings greater than 15% and account for roughly 20% of a project's overall utility cost savings.[23]

Interviewees stated that newer energy efficiency and solar technologies such as solar PV and heating and cooling equipment sometimes failed to meet performance expectations. Several professionals we spoke with explained that this could be due to improper equipment installation, building design challenges, or building staff not having sufficient training to operate, recalibrate, and maintain these technologies.

King and Perry (2017) stated that many building operators do not have knowledge of or experience with new technologies. Most are also inexperienced in analyzing energy and water usage data. This is in part due to how the multifamily housing industry has traditionally defined building operators' roles. Owens (2013) conducted a survey of

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[22] PPAs are subject to price risks. While a PPA's agreed-to price for electricity will be lower than the current retail price, these rates can vary over time. If future rates decrease, a PPA buyer will pay a higher rate than they would otherwise. If rates increase, the PPA provider will realize a smaller return or even a loss.

[23] Building owners utilized funding from water utilities or programs such as LIWP-MF and the Connecticut Green Bank to help cover the upfront cost of installing these measures.

multifamily building operators to determine how much time and attention operators dedicated to different tasks. The study then enlisted a panel of subject matter experts to evaluate the survey's results and recommend which tasks should receive greater attention. Both the survey and panel determined that monitoring and improving building performance should only account for roughly one-quarter of an operator's job. This limited attention to building performance can leave operators with little time to train on using new equipment. Furthermore, while the panel argued operators should have knowledge of energy efficiency and water conservation measures, they did not recommend the same for solar systems.

To ensure that projects achieve their projected energy and water savings, all those we examined used an energy and water benchmarking service to monitor performance after project completion.[24] These services help address building performance challenges by providing ongoing remote monitoring of a building's utility usage data and suggestions for improving lackluster performance (WegoWise 2017b; Bright Power 2018).

### *WHOLE-BUILDING STRATEGIES*

Henderson (2015) argues that owners of larger and older affordable multifamily buildings are more likely to pay for an entire building's utility costs because fewer of these properties have been designed to accommodate individual utility meters for each apartment unit. Owners of these properties invest in energy efficiency and solar measures not only because they are responsible for all utility costs, but also because these expenses tend to be higher on a per-unit basis than individually metered buildings where tenants pay their own utility bills.

However most multifamily buildings are individually metered, and many owners of these buildings are unsure how to financially justify an investment that reduces renters' energy expenses but does little to increase owners' NOI (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 efficiency and solar investment. For this reason, most interviewees with individually metered buildings stated that they only installed energy efficiency upgrades and rooftop solar systems to offset an owner's energy costs.

Those that have invested in energy efficiency and solar systems to benefit renters have achieved financial returns through utility allowance adjustments. As we have pointed out, using utility allowance adjustments to increase rents leads to greater cash flows for owners, but 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.[25] If energy efficiency upgrades and solar equipment fail to meet expectations, renters can see a net increase in their household

[24] All programs analyzed for this report require the use of benchmarking services.

[25] In some cases, owners may raise rents less than permitted by a utility allowance adjustment. This typically occurs in areas where market conditions will not support charging tenants the maximum possible rent. Renters may see some financial benefit in these instances.

expenses after accounting for an increase in rent (Stone et al. 2004). Any HFA allowing project-specific utility allowances should ensure that agency staff know how to verify the energy savings used to increase rents. This is critical to ensure that renters are not subject to unjustified rent increases (Bartolomei 2017).

## Emerging Approaches

We have described some of the common approaches used by affordable multifamily building owners in projects combining energy efficiency and solar resources. However several organizations and utilities are experimenting with innovative approaches to overcome some of the challenges these projects encounter.

### *TARGETING SMALLER MULTIFAMILY BUILDINGS*

The nonprofit ICAST (International Center for Appropriate and Sustainable Technology) is currently working to create opportunities for owners of small multifamily buildings to participate in clean energy projects.[26] ICAST acts as an energy service company and provides access to financing through the CDFI it manages. The organization provides a one-stop-shop service including planning, design build, and financing for small multifamily-building energy efficiency and solar projects. Owners of small multifamily properties and portfolios have few options for financing their energy efficiency or solar projects. Success stories have been mostly limited to owners of large portfolios who can achieve economies of scale to attract large service providers and financial institutions. While ICAST continues to help individual small-multifamily-property owners conduct energy efficiency and solar projects, its current focus is on aggregating these small projects to achieve economies of scale. ICAST is diligently working to develop a program that will help all multifamily properties, including those being served by other energy service companies, to lower costs and access low-cost financing through its aggregation approach. ICAST expects this new program will allow small multifamily properties to gain access to the same, if not better, financing and cost-competitive services as their larger colleagues have enjoyed in the past.

### *UTILITY-OFFERED COMMUNITY SOLAR*

In discussing renewable energy, our research focuses primarily on customer-sited rooftop PV systems. Community solar is an alternative approach for providing solar energy generation to multifamily residents. Such systems are typically located off-site, and residents directly receive bill credits from renewable energy generation. These systems may be owned and managed by utilities, solar companies, building owners, resident cooperatives, or other third parties. While there is no guarantee that community solar initiatives will provide households with energy efficiency upgrades, some program administrators are offering both.

In 2017, the Minnesota Public Utilities Commission approved an Xcel Energy pilot program that will provide residents of a low-income Minneapolis neighborhood with bill credits from a community solar project. The program will also provide residents of both single and multifamily homes with no-cost energy audits and energy efficiency upgrades (Y. Pfeifer,

[26] For more information see icastusa.org.

community energy efficiency manager, and J. Peterson, senior regulatory analyst, Xcel Energy, pers. comm., October 25, 2017). Austin Energy (2018) recently began a citywide community solar program that reduces participants' electricity rates and provides them with no-cost energy efficiency upgrades. Utility-sector programs such as these overcome the split incentive barriers to reducing tenant energy use, but other incentive offerings are still needed to address whole-building energy use.

### *NONPROFIT COMMUNITY SOLAR PROJECTS*

In contrast to utility-run programs, several local community nonprofits are constructing their own community solar projects and pairing subscription offers with energy efficiency upgrades. Emerald Cities Seattle and Spark Northwest have collaborated to create a local-level program that installs rooftop community solar systems on not-for-profit affordable housing properties undergoing energy efficiency retrofits.[27] While still being developed, the project's aim is to share energy savings generated by these solar installations among renters and building owners. The Seattle Office of Housing is assisting with the initiative by streamlining the delivery of utility and federal weatherization funds to help pay for electric efficiency measures. Other project rehabilitation funding is provided by conventional loans and LIHTC. Development of community solar systems is being funded with city-provided grants and tax equity from the federal ITC. These systems are being planned for the roofs of three affordable multifamily properties with 147 low-income residents. When complete, the systems will have a combined capacity of 158 kW.

WinnCompanies recently added a 651 kW community solar array to its Atlantic Terrace Apartments in Washington, DC, to help save residents nearly $500 a year in energy costs (WinnCompanies 2018). Atlantic Terrace Apartments, along with nearby property Atlantic Gardens, underwent a $69 million rehabilitation to preserve 303 apartments as project-based voucher housing. DCSEU contributed incentive funding to help cover the cost of energy efficiency upgrades for the buildings. HUD, the DC Department of Housing and Community Development, the DC Housing Finance Agency, Citi Community Capital, and Boston Financial Investment Management provided additional rehabilitation funding (WinnCompanies 2015). Installation of the community solar system was supported with a $1,347,737 Solar for All grant from the DC Department of Energy and Environment (DOEE 2018). System owner and operator Open Market ESCO LLC is using the grant to provide residents of the 195-unit property with free 15-year community solar subscriptions and education on the benefits of the subscriptions.

## Recommendations

### *ENERGY EFFICIENCY AND SOLAR PROGRAMS*

To successfully integrate both energy efficiency and solar resources into their buildings, affordable multifamily owners are combining incentives, financing, and offers of predevelopment support from multiple sources. Our research suggests that the program administrators providing this funding should pursue the following actions.

[27] For more information see sparknorthwest.org and emeraldcities.org/cities/seattle.

*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. Some interviewees suggested that administrators could offer higher incentives for energy efficiency improvements than for solar systems as an alternative approach to requiring these upgrades. This approach is not currently being implemented by any known program.

*Designate program staff who will serve as the primary point of contact for applicants wishing to take advantage of efficiency, solar, and water conservation program offerings.* Many solar incentive programs operate independently of energy efficiency and water conservation programs. Adding to this complexity, these programs may be targeted at either residential or commercial customers while multifamily customers can be either. Programs such as these are often most effective when they provide participants with a single point of contact, typically referred to as a one-stop shop, rather than relying on applicants to navigate each program's requirements separately (Energy Efficiency for All 2018). Those we interviewed also expressed a need to incentivize staff acting as a single point of contact to work in the best interests of building owners and residents. As we have highlighted, California LIWP-MF works with partner organizations and companies to provide applicants with a one-stop shop.

*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. A project's predevelopment workload also increases if plans call for energy savings that benefit renters. Programs will need to provide participants with added financial or staff support in the early stages of project planning.

*Provide increased funding for structural, systems, health, and safety building upgrades that must be completed before installing energy efficiency measures and solar PV.* Many affordable multifamily buildings need repairs to protect the health and safety of residents or extend the life of the building before the installation of energy efficiency and solar resources. This is particularly true for buildings with roofs in poor condition. Missed repairs on a roof can translate into missed opportunities for both energy efficiency upgrades and a solar installation. Some buildings may also require costly upgrades to their electrical system before installing solar PV. Programs should provide increased funding for such repairs or partner with an organization that can do so. Examples of potential partners include community development finance institutions (CDFIs), green banks, and private foundations.

*Encourage energy efficiency contractors, solar installers, and energy auditors to work collaboratively.* Energy efficiency and solar professionals often know little about each other's work. Consequently efficiency and solar contractors remain narrowly focused on their respective fields and rarely coordinate work on a building. Program administrators have an opportunity to align the interests and work of these two groups by providing opportunities

for contractor cross-training, establishing protocols for continual communication, and requiring that energy auditors be trained in evaluating a building for both energy efficiency upgrades and solar systems. Collaboration among these workers can also help increase accountability, helping to ensure that projects will be carefully designed with new equipment in mind and that such equipment will be installed properly (AccountAbility 2008). It is critical that program staff require solar installers to use a building's post-retrofit energy use when sizing a rooftop system.

*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 that 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.

*Educate tenants about the installation, use, and benefits of a building's energy-efficient equipment and solar systems. Encourage energy-efficient behaviors for residents.* Multiple interviewees stated that educating tenants about energy efficiency and solar equipment was critical to ensuring that projects proceeded with little opposition and generated expected energy savings. Residents should understand how to operate any equipment in their unit upon move-in or installation, and they should be informed about energy-efficient behaviors and their benefits. Both Foundation Communities and Connecticut Green Bank have integrated resident education in their work.

*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. However programs should be careful not to oversubsidize projects that are also making utility allowance adjustments. Doing so results in larger-than-necessary incentive payouts and few, if any, financial benefits for tenants. Administrators should take steps to ensure that owners are sharing financial returns with building residents.

### *GREEN FINANCING OPTIONS AND UTILITY ALLOWANCES*

Complementary to utility-sector incentive programs, private lenders play a critical role in facilitating investments in affordable multifamily energy efficiency and solar projects. 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). The loan can be issued with either a first or second lien on the property, giving owners the flexibility to combine it with other financing options as needed. When combined with program incentives, financing products such as these improve the chances that an owner will make investments that reduce tenant energy use.

Our research also supports previous research findings that HFAs can use utility allowance adjustments to help incentivize owners to make energy efficiency and solar investments that lower renters' energy expenses. In cases where affordable multifamily buildings are individually metered, owners may consider energy efficiency and solar investments if they can be recouped through higher rents. Renters may not benefit financially from these projects if utility allowances are adjusted fully. They will see lower overall housing and utility costs only in cases where utility allowances are partially adjusted. For example, Stone et al. (2004) suggested that utility allowances could be adjusted by 75%, leaving a 25% cost savings for renters. While such adjustments can be made intentionally, Foundation Communities pointed out that some housing providers may not be able to alter allowances fully because of soft market conditions. Even if renters do not benefit financially from energy efficiency and solar investments in affordable housing, they stand to gain other advantages. NMR and Tetra Tech (2011) found that energy efficiency upgrades can improve tenants' indoor air quality, comfort, and satisfaction with building and unit equipment. These improvements can enhance a household's mental health and propensity to remain in a home for an extended time, leading to improved academic performance for children (Norton et al. 2018).

### *BUILDING OPERATOR TRAINING AND RECRUITMENT*

Affordable multifamily building owners must often install new energy technologies to achieve deep energy savings. However, as we have noted, many building operators are unfamiliar with how to properly operate and maintain new equipment. This is true for both newer energy efficiency technologies and solar systems. Building owners will be more likely to install newer technologies if they believe building staff can operate and maintain them.

Three-quarters of professional and business services professionals, like those that own and operate multifamily buildings, report some difficulty in hiring energy efficiency professionals. Lack of training is the most-cited reason for this obstacle (DOE 2017b). King and Perry (2017) recommend that manufacturers and trade associations provide training to improve building operators' knowledge of these technologies. Alternatively an ESCO that contracts with a building owner to reduce a property's energy use can provide building operator training (Baechler and Webster 2011). Energy efficiency and solar incentive programs may also be able to assist in providing building operators with needed training and other support.[28] For example, Puget Sound Energy launched the Multifamily Retrofit Strategic Energy Management pilot program in 2017 to improve the operation and maintenance of multifamily buildings. The pilot program provides building staff with no-cost trainings, assistance developing energy management strategies, monthly check-ins to review progress, and a year of building performance tracking for 10 buildings (PSE 2018). Program administrators can work with property managers to promote opportunities such as

[28] For more information on best practices for the operation and maintenance of energy-efficient equipment see energystar.gov/buildings/facility-owners-and-managers/existing-buildings/save-energy/comprehensive-approach/operations-and. For more information on best practices for the operation and maintenance of solar PV systems see nrel.gov/docs/fy17osti/67553.pdf.

these for their staff. They may also be able to incorporate hands-on training for staff as new equipment is installed.

State and local policymakers should also consider ways to encourage a new generation to pursue careers as building operators. Twenty-four percent of professional and business services employers report that hiring an energy efficiency professional has been difficult because the applicant pool is too small (DOE 2017b). Goldman et al. (2010) found that new energy efficiency services jobs, like those that focus on building operations, will likely need to be filled with those currently working in building and construction professions. However current workers in these industries lack educational opportunities to prepare them for these positions. Community college, university, and union apprenticeship courses that focus on energy efficiency technologies and practices are in high demand, but few such programs exist (Saha 2010). State and local policymakers can pursue the following actions to address these challenges:

- Adopt policies that require or incentivize building owners to pursue energy efficiency and solar investments. This increases the value of building operators' work (Keicher 2010).
- Work with local or regional stakeholders to identify building operator job opportunities and the specific training that building and construction workers will need to fill those positions (Keicher 2010; Saha 2010).
- Provide funding for community colleges, universities, and union apprenticeship programs to expand the number of students and instructors participating in courses focused on high-performance building operations. Alternatively, direct that instructors integrate a high-performance building curriculum in existing relevant coursework (Goldman et al. 2010).

## Conclusions

Several states, local governments, and utilities have established policies and programs that encourage investors to back projects combining solar PV and energy efficiency in multifamily buildings. Many of these decision makers have prioritized low-income household access to these resources, opening opportunities for affordable multifamily building owners and developers to pursue deeper energy efficiency and solar projects. However utility-sector decisions regarding electricity rates, net-metering policies, and incentive program design can have a substantial effect on which building owners and developers can complete projects and whether those projects benefit renters.

While our research indicates that combining energy efficiency and solar resources in affordable multifamily buildings can result in substantial energy 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. This report has been limited to analyzing a small sample of completed projects and active programs. Most successful projects we examined occurred across several properties in a large housing portfolio. More research is needed to understand how owners of smaller affordable housing portfolios can install these resources in their buildings. Additional research is also needed to analyze how emerging community solar programs can encourage energy efficiency upgrades in affordable multifamily buildings.

We can conclude from our research that solar projects have the potential to encourage investments that substantially increase the energy efficiency of affordable multifamily buildings if property owners are able to secure adequate financing and subsidies. For many building owners, reducing utility costs with solar systems, energy efficiency upgrades, and water conservation measures is financially sensible. With the right combination of reliable measures and performance monitoring, these investments increase an owner's net operating income and further the mission to preserve and expand affordable housing for low-income renters.

Owners' portfolio-wide approaches to installing solar open opportunities for energy efficiency programs to make upgrades across multiple buildings at once. Our research reveals that housing providers installing solar systems make a wide range of energy efficiency improvements. It is critical that policymakers and program administrations encourage or require owners to make these upgrades in addition to installing a solar system. Doing so helps hedge against operating risks associated with solar systems and other newer, emerging technologies. If done effectively, combined energy efficiency and solar resources in affordable multifamily buildings can deliver energy savings, generate financial returns for investors, increase affordable housing, and improve renters' health and well-being.

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