Cost-Effective Solar Strategies for Affordable Housing in New York State

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Final Report

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Abstract

Under Request for Proposal (RFP) 3750, New York State Energy Research and Development Authority (NYSERDA) awarded a total of six contracts to six different solution-provider teams to develop retrofit solutions reaching or approaching net zero energy for six affordable housing buildings. Through this effort, it became evident to NYSERDA's RetrofitNY staff that a number of barriers exist to installing cost-effective solar PV on affordable housing. This report summarizes barriers to cost-effective solar for affordable housing and identifies solutions that could allow owners to overcome these barriers. Specifically, the report identifies opportunities to reduce upfront cost, leverage additional incentives, increase the value of solar, utilize creative financing, or otherwise increase the technical and financial viability of utilizing solar to achieve net zero electricity consumption in multifamily buildings. While Solar One developed the report in the context of the RetrofitNY program, many of the recommendations in the report apply broadly to solar on multifamily affordable housing as well as the solar industry at large.

Keywords

Solar Energy, Multifamily Affordable Housing, Net Zero Emissions, Energiesprong, Community Shared Solar, Power Purchase Agreement, Property Assessed Clean Energy, Bulk Procurement, Renewable Energy, New York

Acknowledgments

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Acronyms and Abbreviations

AHJ	Authority Having Jurisdiction
AIA	American Institute of Architects
BIPV	Building Integrated Photovoltaic
BOS	Balance of System
CDFI	Community Development Financial Institutions
CDG	Community Distributed Generation
CESIR	Coordinated Electric System Interconnection Review
C&I	Commercial and Industrial
CLCPA	Climate Leadership and Community Protection Act
CMA	Climate Mobilization Act
CPC	Community Preservation Corporation
DCAS	New York City Department of Citywide Administrative Services
DOB	New York City Department of Buildings
DSCR	Debt Service Coverage Ratio
EPC	Engineering, Procurement, and Construction Services
FDNY	New York City Fire Department
FICO	Standardized Credit Score for Individuals
HCR	New York State Homes and Community Renewal
HDC	New York City Housing Development Corporation
HPD	New York City Housing Preservation and Development
HUD	Department of Housing and Urban Development
HVAC	Heating, Ventilation and Air Condition
IPC	Inclusive Prosperity Capital
ITC	Investment Tax Credit
JOE	Joint Ownership Entity of New York City
LCOE	Levelized Cost of Electricity
LIHTC	Low Income Housing Tax Credit
LMI	Low- and Moderate-Income
MTC	Market Transition Credit

NREL	National Renewable Energy Laboratory
NYCEEC	New York City Energy Efficiency Corporation
NYCHA	New York City Housing Authority
NYGB	New York Green Bank
PACE Financing	Property Assessed Clean Energy Financing
PII	Permitting, Interconnection and Inspection
PPA	Power Purchase Agreement
PSC	Public Service Commission
PTO	Permission to Operate
PV	Photovoltaic
RFP	Request for Proposals
ROI	Return on Investment
SAPC	Solar Access to Public Capital
Solar APP	Solar Automated Permitting Process
VDER	Value of Distributed Energy Resources Electricity Tariff

Executive Summary

Cost-effective solar deployment strategies are critical to RetrofitNY's goal of developing scalable models for deep energy retrofits and net zero multifamily construction. Solar PV costs have declined significantly in the last decade. However, the upfront cost of solar PV is still the single greatest barrier to adoption. Overcoming this barrier will catalyze significant expansion for solar deployment and, through the diverse strategies recommended in this report, can help make solar cost-effective for affordable housing.

The report summarizes the drivers of solar costs and highlights high-impact strategies for reducing costs or otherwise increasing the financial viability of integrating solar into deep energy retrofits. In addition to a broad overview of cost drivers and strategies for cost reduction, this report delves into specific challenges to solar installation on multifamily affordable housing, in both the urban and rural context. It also explores the intersection of solar PV and the Energiesprong model and ways that solar PV can be cost-effectively integrated into whole-building deep energy retrofits. These strategies cut across several focus areas, including financing, technology development, solar energy company operations, business model integration, municipal processes, and public policy. Each section concludes with a list of recommendations for NYSERDA's consideration. Ultimately, NYSERDA's RetrofitNY team will need to focus on the subset of strategies it believes are most impactful and within the purview of its programmatic mandate, while other NYSERDA divisions and external parties can advance other strategies. Key challenges identified in this report include the following:

- The nascent market for Energiesprong deep energy retrofits
- Prohibitive upfront cost
- Affordable housing providers' inability to directly monetize tax incentives
- Extensive predevelopment timelines for retrofit projects
- Lengthy and redundant Authority Having Jurisdiction (AHJ) approval processes
- Design challenges unique to the urban context
- Complicated solar energy compensation methods and perverse incentives
- Limited integration between solar companies and other trades, such as roofing and efficiency
- High upfront costs for small projects
- Incentive programs and public policies that don't adequately encourage solar PV in the affordable housing sector

The following are high-impact strategies to overcome these barriers and increase cost-effective solar deployment for net zero affordable housing:

- Engaging with mature, adjacent markets that use Energiesprong concepts, such as manufactured home companies, to accelerate the development of rapid deep energy retrofit solutions
- Fostering business model integration among solar PV installers, roofers and efficiency companies
- Encouraging bulk procurement of solar PV
- Expanding access to long-term loans and third-party financing
- Propagating standardized RFP templates, customer contracts, and lender/regulator consent processes to reduce predevelopment time and transaction costs
- Encouraging unified, automated permitting and inspection processes among AHJs
- Catalyzing the development of low-cost solar canopies for urban applications through competitions, research and development, and commercialization support
- Advocating for utility metering and electrical code solutions to enable cost-effective electrical tie-ins on high-rise buildings
- Promoting on-site community solar and master metering conversions to increase the value of solar, eliminate split incentives between owners/renters, and to maximize solar PV system size
- Exploring the political feasibility of refundable tax credits to increase applicability among nonprofit affordable housing providers, incentive program design optimization, and incentives that help defray the cost of roof repairs prior to solar PV installation
- Encouraging solar mandates for new construction and substantial renovation projects

These recommendations, detailed in the body of the report, are oriented toward NYSERDA while recognizing that a diverse group of stakeholders, including municipal, State, and federal agencies, solar installation companies, and technology providers, will all play a role in bringing cost-effective solar PV to affordable housing in New York State.

Figure ES-1. Rooftop Solar Array on an Affordable Cooperative, Harlem, New York City

Source: Solar One

1 Solar and the Energiesprong Model

The Energiesprong model is a program developed in the Netherlands that seeks to reduce the cost of net zero retrofits by using highly efficient materials, prefabricated construction, and a long-term efficiency guarantee to help finance the retrofits. With a whole-building solution, systems can be designed to work together in order to eliminate material waste and achieve higher efficiency. Large-scale Energiesprong campaigns with government support can achieve economies of scale, which will ultimately lead to the creation of a robust market for affordable, whole-building energy upgrades. Strategies and technologies developed for net zero retrofits may inform, and benefit from, parallel efforts to scale net zero prefabricated new construction buildings. RetrofitNY is New York State's adaptation of the Energiesprong model that seeks to develop standardized, scalable solutions and processes that will improve the aesthetic and comfort of residential buildings, while dramatically improving their energy performance.

While Energiesprong reduces energy consumption within a given property, it also eliminates fossil fuel-based heating, cooking and hot water, thereby increasing the need for electricity. Solar PV is commonly the primary source of power for net zero buildings, as its modular technology is adaptable for diverse retrofit and new construction applications, and, importantly, it can generate electricity without emitting any carbon dioxide or other pollutants. This section discusses solar PV's role in Energiesprong deep energy retrofits as well as how solar can be integrated into new net zero manufactured homes and modular homes: a promising existing industry that can help scale up the implementation of Energiesprong technologies and concepts in New York State.

1.1 Prefabricating Elements

One of the main elements of the Energiesprong model is the prefabrication of exterior cladding in a factory, which can then be shipped to the site and installed in a matter of days. This approach has a number of benefits; for example, in the factory, construction can continue regardless of the weather (one of the largest causes of construction delays), and the materials are less exposed to the elements during the construction process, which reduces wear and tear before the project is even completed. Another significant benefit is that centralized production can be standardized, allowing manufacturers to achieve economies of scale and compress costs by maximizing equipment/tool utilization with

24-hour production at the factory, and reducing labor costs through automation technology which is easier to implement in assembly lines than in the field. Finally, custom prefabrication enables efficient installation, limiting on-site work to placement, connecting wires/pipes, and sealing the junctions of the prefabricated panels.

Solar companies typically install solar PV on existing roof systems, with work occurring in fair weather and during daylight hours. However, with the Energiesprong model, solar panels can be installed at the factory where the roofing system and external cladding are assembled. Installing solar at the factory would enable the solar PV system to benefit from the same prefabrication benefits described above, and the roof sections with solar PV could then be shipped to the construction site for simple, quick assembly.

Figure 1. Automated Solar Panel Manufacturing

Source: Energy Central

In the last decade, solar panel manufacturing has achieved major cost reduction due to increased scale, automation and more. In a factory context, solar PV installation could achieve similar cost compression. Benefits of installing solar PV at the factory rather than in the field include the following:

- Reduced solar PV equipment costs through bulk procurement at the factory.
- Reduced labor costs through automation, efficient labor utilization, and labor arbitrage (factories can be located in areas with lower costs of living than the point of final delivery).
- Faster installation times due to efficient labor utilization, 24-hour operations (depending on the scale and shift structure of the factory), and the elimination of weather delays.
- Reduced design, engineering, permitting, and interconnection costs through standardization and combining scopes of work.
- Reduced worker injuries, illness, and safety incidents, achieved through controlled indoor work environments, factory safety monitoring (easier and lower cost than field safety monitoring), and decreased amount of time workers spend on roofs and elevated structures.

While it is difficult to quantify these cost-saving benefits, the benefits could be significant with manufactured home or external cladding manufacturers operating at scale. However, these benefits are only achievable if/when there are factories serving New York State that manufacture external cladding and other systems for rapid modular deep energy retrofits. Additionally, prefabricated solar PV is only an option in cases where the deep energy retrofit includes the application of a new roof or a significant exterior cladding on the existing roof with sufficient structural integrity to support the solar PV system's mechanical attachment.

1.2 Combining Solar with Efficiency Retrofits

The beauty of the Energiesprong program is its comprehensive approach: taking a single opportunity to overhaul heating and lighting systems while installing solar PV and upgrading insulation. This approach reduces total construction time and allows for complimentary system design (e.g., sizing the solar PV system to account for the addition of heat pumps). Often solar and energy efficiency are undertaken as different—and competing—projects. Building owners choose between solar or efficiency upgrades, either for budgetary reasons or because two different providers are pitching them on different projects. It is an unfortunate reality of the solar PV and energy efficiency businesses that, faced with a choice of either solar or efficiency work, buildings frequently opt to either do only one project or neither, feeling overwhelmed with the complex choices.

With Energiesprong, multiple scope items are combined into one cohesive project, so the elements are designed to fit together. The program is designed to be affordable, so building owners do not have to make financial choices between solar and efficiency. The upfront cost barrier for solar PV and deep energy retrofits is discussed in depth in this document; however, with appropriate financial support from governmental and financial institutions, deep energy retrofits with solar PV can be financed over an extended period of time with a loan that underwrites tenant utility bill savings. The following page includes photos from a few of the Netherlands' first 5,000 deep energy retrofits through Energiesprong. These projects prominently feature solar PV systems, installed using standard solar PV installation methods.

1.2.1 Examples from Energiesprong in the Netherlands

Figure 2. Net Zero Townhouses

Source: Stroomversnelling

Figure 3. Attached Home Net Zero Retrofit

Source: Stroomversnelling

1.3 Economies of Scale

A key strategy to cost reduction for Energiesprong deep energy retrofits is aggregation: both combining scope items within a single building and amongst many buildings as part of a larger project or company operation. The Energiesprong program is still in development in the United States, however as it scales up, integrating solar into a factory-based retrofit process may allow for economies of scale in the solar PV scope of work, achieved through bulk procurement of solar modules, efficient/low-cost installation, and automation.

1.4 Tenant Energy Payment

One of the largest barriers to efficiency or solar on rental buildings is the split incentive problem, where the building owner has little to no incentive to make building upgrades that will primarily benefit the tenants. The Energiesprong model counters that with an "energy payment" made by tenants after the retrofit which accounts for most of the savings from utility bill reduction and allows the building owner to repay the investment over time. Tenant energy payments are supported by long-term guarantees from the retrofit provider, so tenants will not be forced to make higher payments if the retrofits underperform and their energy costs are higher than forecast. The concept behind tenant energy payments and underwriting savings are critical components of the model that will allow its growth. Regardless of the financing mechanism, solar PV, with its reliable and easy-to-forecast clean energy generation, can be a critical component of a tenant energy payment or comparable program.

1.5 Additional Considerations: Modular and Manufactured Homes

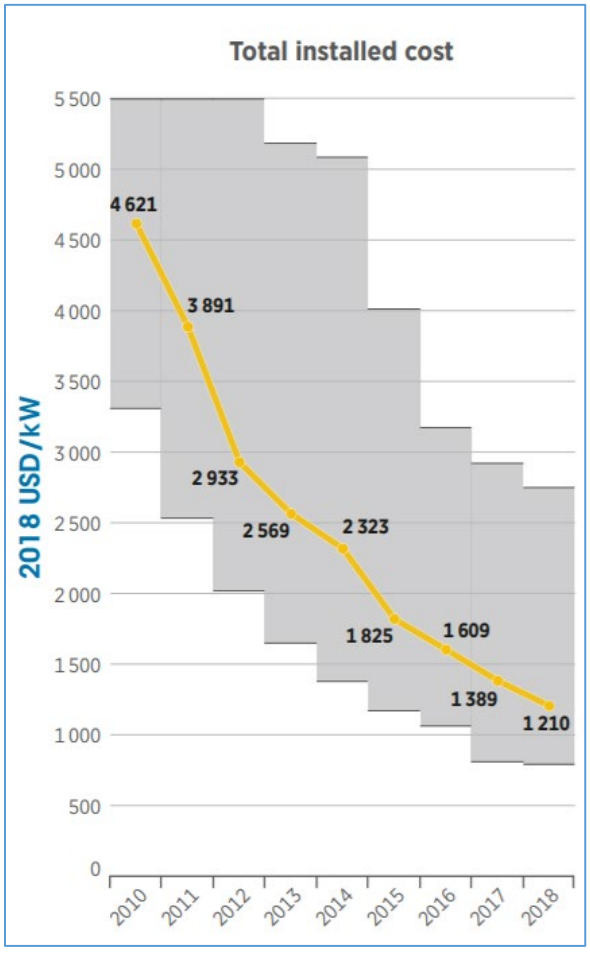
While the primary focus of RetrofitNY is deep energy retrofits of existing buildings, this analysis has identified modular and manufactured homes as a critical market segment that could benefit from the deep energy retrofit strategies developed under the Energiesprong/RetrofitNY program, particularly with assembly line style installation of cost-effective solar PV. An estimated 22 million Americans live in manufactured homes,[1] and many companies manufacture such homes in and around New York State. These companies, with existing factories and supply chains, represent a significant opportunity for the RetrofitNY team to develop novel partnerships that accelerate the deployment of net zero housing. For manufactured home companies, deep energy retrofits could also represent an opportunity to diversify product offerings and revenue streams. This diversification could allow such companies to grow and to become more resilient amid fluctuations in the new housing market, which is relatively elastic and notoriously cyclical. Section 8 of this report focuses on the opportunity for net zero manufactured homes as well as partnership opportunities for NYSERDA to consider in this sector.

2 Solar Cost Drivers Analysis

Solar PV is the primary source of power for net zero buildings around the world. Affordable solar PV is necessary to the success of net zero retrofits/construction, and it is critical to understand the cost drivers of solar PV technology and installation in order to develop an effective cost-reduction strategy. Fortunately, over the last ten years, the average cost of solar electric systems has declined precipitously. According to the International Renewable Energy Agency (IRENA), the weighted average installed cost of solar PV declined from $4.62/Watt-DC in 2010 to $1.21/Watt-DC in 2018.[2]

Figure 4. Global Turnkey Solar PV Cost Trend

Source: International Renewable Energy Agency.



These cost reductions were the result of (1) reduced raw material rates (silicon), (2) increased solar PV manufacturing capabilities globally, largely driven by China, and (3) solar installation companies improving the efficiency and scale of their operations. These cost reductions were largely driven by silicon solar PV manufacturers; however, the hard costs reductions created a positive feedback loop

with downstream industries that increased their scale and efficiency. The graph on this page displays the global solar PV installed cost trends, although there is significant cost variation between sectors and locations. For example, the utility-scale solar sector has much lower costs than the residential and small commercial sectors. Similarly, the installed cost of solar PV in China is lower than the United States due to differences in labor and other costs. Despite the significant reductions to the installed cost of solar PV, the upfront cost is still a significant barrier to adoption for affordable housing. This section of the report summarizes overall solar PV cost trends and the drivers of these costs. These drivers are referenced throughout the report as it describes various strategies for reducing expenses and otherwise accelerating the adoption of solar PV.

2.1 Solar PV Cost Trends

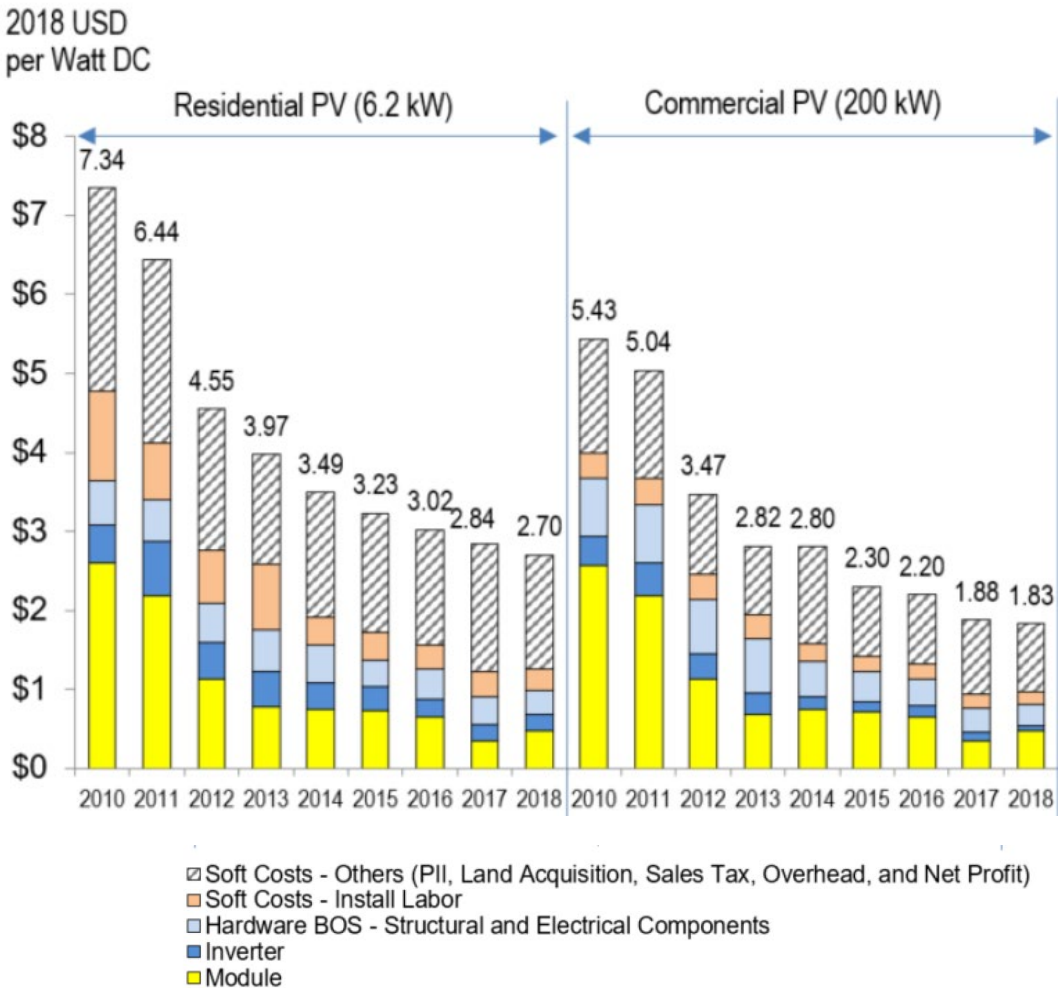
The solar industry represents solar costs in dollars per Watt-DC, which is the primary metric discussed in this report. However, levelized cost of electricity (LCOE), which is the total cost of the solar energy system in net present value divided by the expected lifetime solar energy generation, is equally important. LCOE enables easy comparison of solar PV with a building's avoided cost of electricity from the utility company. When the LCOE of solar PV drops below the utility rate, "grid parity" is achieved. The two biggest drivers of grid parity are the installed cost of solar technology and utility rates. However, as solar panel technology improvement increases the longevity of panels and reduces operation and maintenance (O&M) expenses, this also contributes positively to LCOE reductions and accelerates the achievement of grid parity in areas where solar PV was not previously cost effective.

2.1.1 National Cost Trends

Solar cost trends in the United States correlate strongly with global trends, with significant cost reductions across all sectors in the last decade. In 2011, NREL launched SunShot, an initiative aimed at reducing the cost of solar PV in the United States across all market segments. SunShot has yielded significant research on solar cost drivers, referenced in this report, as well as many innovative strategies for solar PV cost reduction that been adopted by public and private sector actors. The chart below, from the National Renewable Energy Laboratory (NREL), demonstrates cost trends in the United States. NREL evaluated residential solar projects separately from commercial solar projects because their cost structures are significantly different.

Figure 5. United States Turnkey Solar Cost Trend by Sector

Source: National Renewable Energy Laboratory.

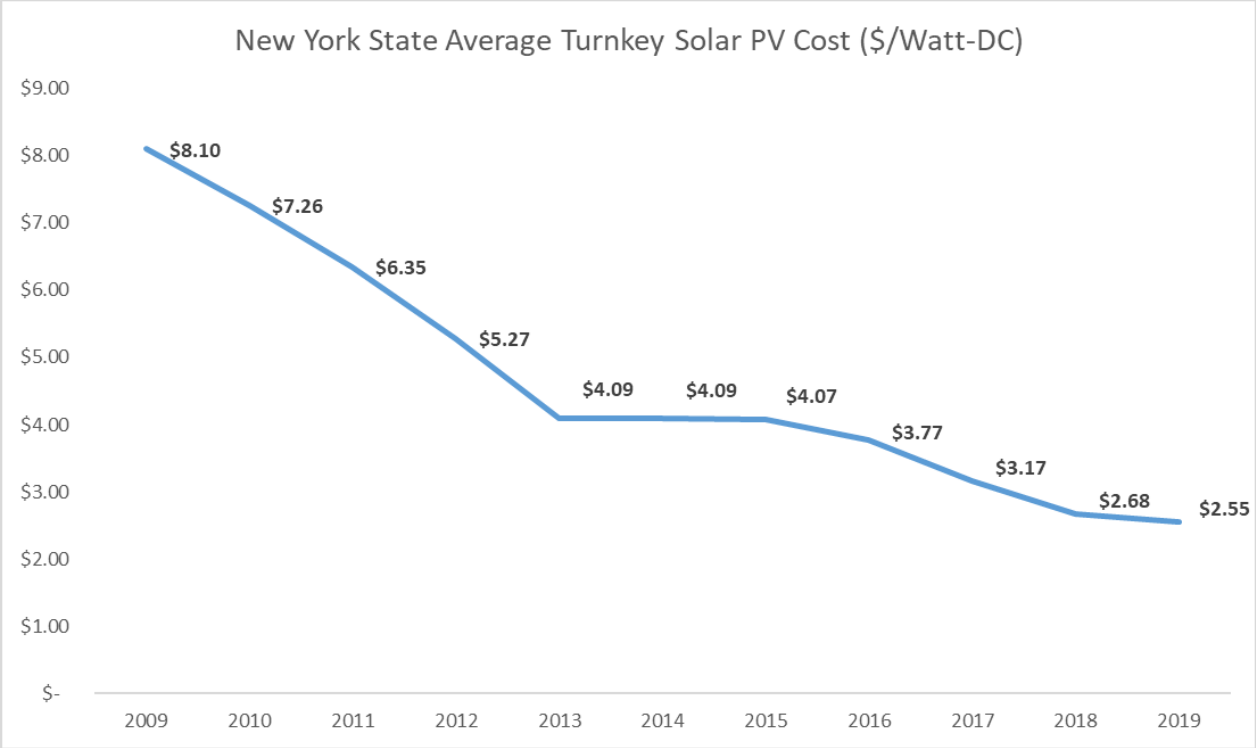


2.1.2 New York State Cost Trends

New York State's solar installation costs closely mirror national trends, albeit with higher average installed costs for PV systems in New York City due to factors such as increased permitting, interconnection and inspection (PII) and labor costs. NYSERDA collects total installed cost data for all solar projects that participate in its NY-Sun incentive program; however, it does not gather itemized costs data necessary for cost driver analysis. The following section relies on national data compiled by NREL and anecdotal evidence from Solar One's experience facilitating solar projects in the State.

Figure 6. New York Turnkey Solar Cost Trend

Source: NYSERDA.[3]



2.2 Solar PV Cost Drivers

Cost drivers for solar PV are typically divided into two major categories: hard and soft costs. Hard costs include hardware, such as solar PV modules, inverters, racking and balance-of-systems (BOS). Soft costs include everything else: installation labor, customer acquisition, PII, financing, and profit/ overhead. Pricing for solar PV modules and inverters is influenced by global commodity prices, labor markets, upstream manufacturer investments, and international trade agreements. New technologies can also drive down these hard costs; however, they are not easily impacted by project and program level strategies and are beyond the scope of this analysis. Soft costs are responsible for more than 50% of the total cost of solar in the United States, and they present the greatest opportunity for cost reduction through efforts such as RetrofitNY.

2.2.1 Hard Costs

The single biggest hard cost for a solar PV installation is the cost for solar modules. After the PV modules, the next most significant expenses are the inverters, followed by the racking system and wiring (aka balance of systems, or BOS). Solar PV module prices have declined significantly in the last decade.

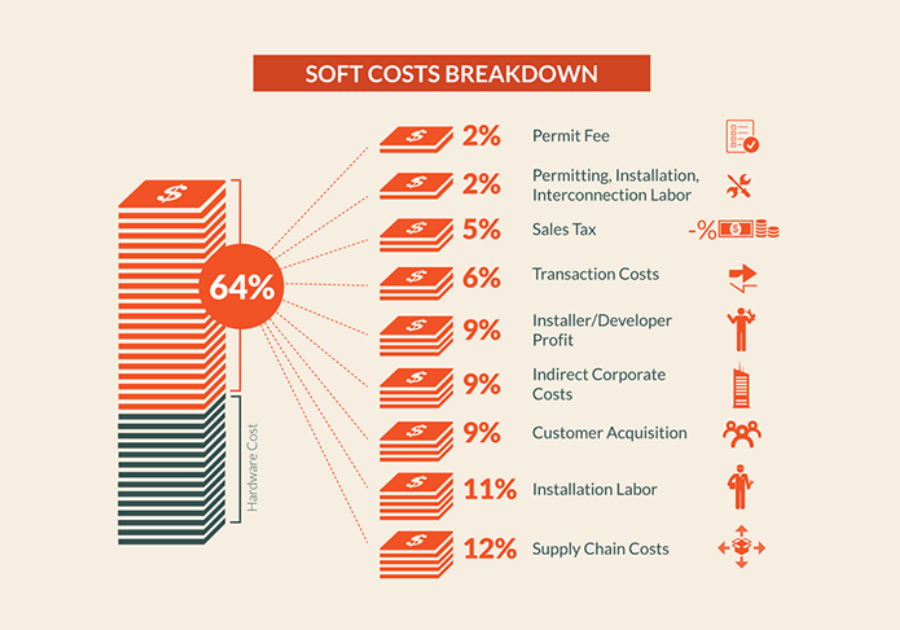
Inverter prices have come down as well, although the greatest cost reductions occurred with solar PV modules. Price reductions for solar PV modules were the result of growth in silicon PV solar manufacturing capacity and increased global competition. The most expensive components of the BOS are the metals used in the manufacture of the materials: aluminum and steel racking systems and copper wires. In the last year, for the first time in many years, solar PV modules and BOS have experienced price increases due to the import taxes (tariffs) that the United States applied to solar PV modules as well as aluminum and steel. Factory gate pricing for solar PV modules and inverters are not the focus of this report, which instead focuses on downstream segments of the market, where there is greater opportunity for impact at the State, program, and project levels.

2.2.2 Soft Costs

Despite the steady decline in solar PV costs in the United States, soft costs remain stubbornly high compared to soft costs in other global solar markets. According to recent analysis completed by the National Renewable Energy Laboratory, soft costs comprise the majority of the total installed cost of residential and commercial solar PV systems in the United States. Soft costs include PII, customer acquisition, installation labor, financing, and profit/overhead for the solar company. These soft costs are higher in the United States than many other markets and represent the greatest opportunity for solar PV cost reduction.

Figure 7. Residential Solar Soft Cost Summary

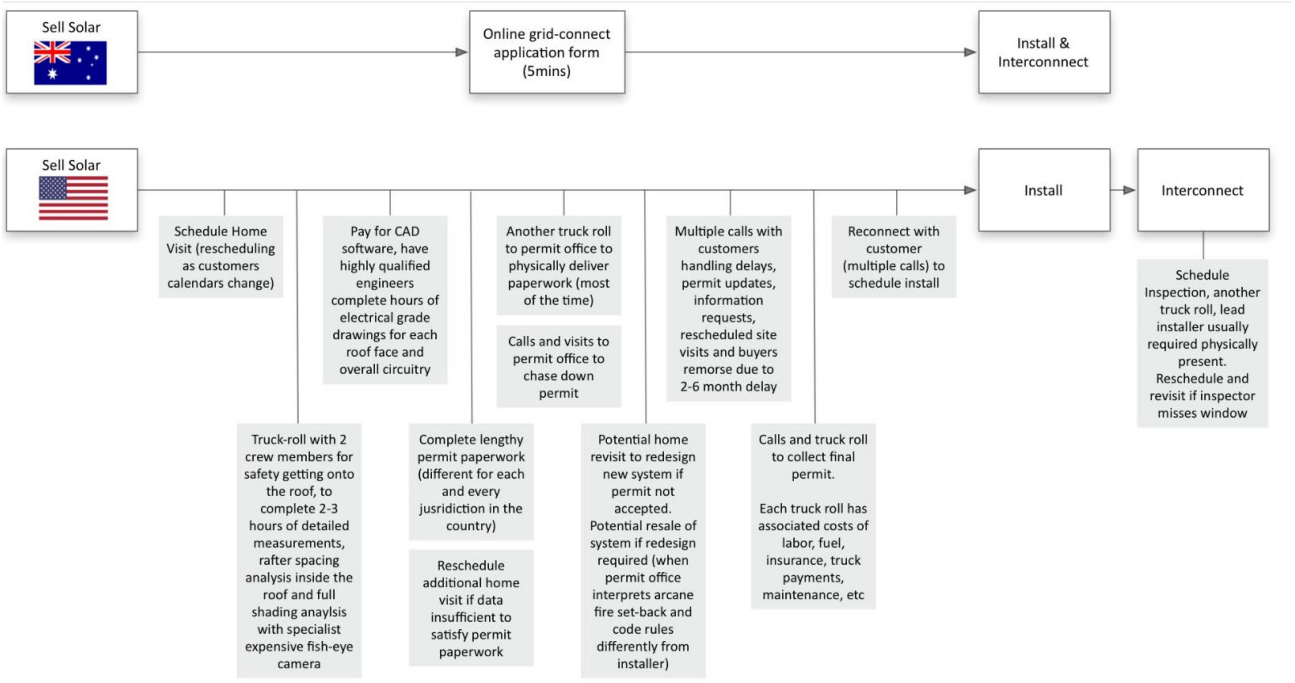
Source: US Department of Energy.[4]



A 2018 Green Tech Media article by Andrew Birch, former CEO of Sungevity, an international solar company that operated in the United States, Europe, and Australia, notes that residential solar projects in the United States cost more than twice as much as in Australia. Mr. Birch's article attributes this cost discrepancy to the unnecessary red tape associated with PII activities for solar in the United States, explained in the chart below.

Figure 8. Comparison of Solar Permitting in the United States Versus Australia

Source: Andrew Birch, Green Tech Media.[5]



Not surprisingly, soft costs are lower, on a percentage basis, for larger solar projects. This phenomenon is a result of fixed costs that can be absorbed by big projects but not small ones. These fixed costs include PII activities as well as operational activities, such as renting a crane or equipment delivery. As system sizes increase and $/Watt-DC costs decrease, this expands the universe of available financing options. Economies of scale is a recurring theme in the report, as aggregating projects or increasing their overall scale is often the most efficient way to drive down $/Watt-DC costs and improve overall project economics.

2.3 Solar PV Cost Drivers for RetrofitNY

The RetrofitNY program focuses on small/midsized multifamily buildings. Solar PV installations on this building type straddle the residential and commercial market segments. Installations on individual midrise multifamily buildings are often the size of a residential solar PV system, and therefore could have a similar cost structure, including high soft costs. However, if solar PV is installed across dozens of adjacent multifamily rooftops, or even on land adjacent to a multifamily development, the installed cost of the solar PV system can be much lower, more reflective of the commercial market. Additionally, prefabricated rooftops with integrated solar PV could allow for installed costs even lower than current commercial solar benchmarks.

This report evaluates key barriers to cost-effective solar PV deployment on affordable housing as well as solutions that can help overcome such barriers. Many of the items discussed in the following sections are not specific to the RetrofitNY program. However, their implementation will result in increased solar deployment, particularly in the affordable housing sector. Section 8 focuses on the specific opportunity for implementing Energiesprong concepts for installing solar PV on prefabricated homes through strategic partnership with the existing manufactured home/modular building industry.

3 Financing

3.1 Challenge: Prohibitive Upfront Investment in Solar

Affordable housing properties often have limited capital reserves and a tight operating budget. Although turnkey solar installation costs have declined significantly in the last decade, the upfront cost of solar PV installation is still prohibitive for many affordable housing buildings/owners. For a building with limited reserves and operating budget, it can be difficult to justify investing in a solar installation—even when there is a strong return on investment (ROI)—due to other projects that are competing for the same limited resource. Cost reduction strategies can help lessen this barrier (discussed in later sections); however, in many cases, financing options can help overcome the barrier entirely.

3.1.1 Proposed Solutions

3.1.1.1 Solution: Zero-Down, Third-Party Financing

Over the last fifteen years, the United States solar industry experienced dramatic growth. This growth was fueled by a reduction to the cost of solar technology as well as the advent of third-party financed solar products such as the solar lease and the solar power purchase agreement (PPA). These third-party financing products gained traction because they allow building owners to install solar with no upfront cost, and to pay for solar energy generated over time at a pre-defined rate that is lower than the utility rate. With this model, the solar company finances, owns, and operates the solar equipment, and they recoup their investment through a combination of solar PPA payments and tax incentives.

The third-party financed solar segment is driven by the United States federal tax incentives available for commercial solar projects, including a 30% Investment Tax Credit (ITC)[6] and accelerated depreciation. In the third-party segment, solar development companies create special purpose entities to own, operate, and maintain solar projects, and capitalize the companies with a combination of tax-equity, cash equity, and debt. The most common model for third-party financing is known as the "partnership-flip," whereby the tax-equity investor is the majority owner of the special purpose entity in order to capture the full value of the solar tax incentives before majority ownership reverts ("flips") to the project sponsor. The complexity of this model requires significant legal and financial resources to execute. While large commercial/utility-scale solar projects can support these legal/financing costs due to their scale, small residential solar projects are too small to finance individually due to the high legal and

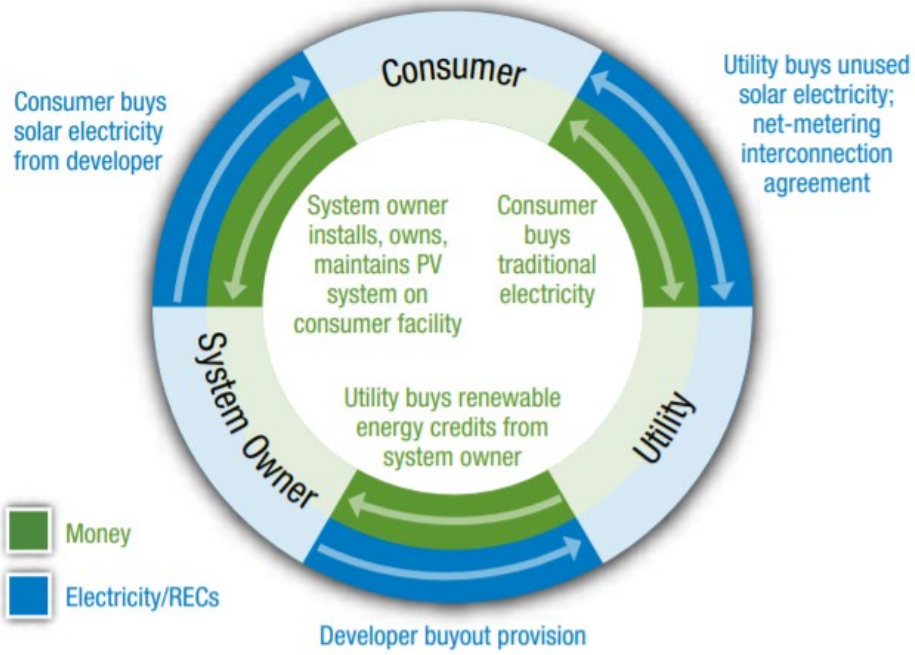
underwriting costs associated with the model. To overcome this barrier, solar development companies, such as Sunrun, Vivint, and Tesla, pool similar residential solar projects into funds and use standardized underwriting criteria, such as homeowner FICO score. This pooling of assets and standardization of underwriting criteria allows solar development companies to reduce their transaction costs, standardize their operations, and raise low-cost capital.

3.1.1.2 Power Purchase Agreement

The power purchase agreement (PPA) financing model is a third-party ownership model through which a solar company purchases, installs, and operates the solar PV system on a customer's property. The customer enters into a long-term contract (typically referred to as the PPA) to purchase 100% of the electricity generated by the system from the system owner,[7] and the system owner recoups their investment through a combination of solar PPA payments, utility/state incentives, and the federal solar tax incentives. For a building owner with limited easy access to capital and/or an inability to monetize solar tax incentives directly, a PPA can be a compelling option, allowing the owner to install solar and save money with no capital outlay.

Figure 9. Contracts and Cash Flow in Third-Party Ownership/PPA Model

Source: National Renewable Energy Laboratory.



3.1.1.3 PPA Availability

PPAs are not available in all 50 states, due to regulatory prohibitions; however, they are permissible in New York. Even in states where the regulatory environment allows PPAs, their availability varies among solar projects and geographies. Solar PPAs require the following conditions:

- Regulatory approval of third-party ownership
- Low $/Watt-DC installation costs and/or
- High electricity rates and/or
- Strong state/utility incentives

A range of different project types with only some of the conditions listed above can be good candidates for a PPA. For example, large solar projects are likely to secure a third-party financier willing to offer a PPA due to low installation costs that come from sheer scale. Residential solar projects, while typically more expensive on a per watt basis, are able to secure a third-party financier willing to offer a PPA due to the customer's high residential electricity rate and the solar companies' ability to complete efficient underwriting based on the homeowner's FICO score.

Small commercial and multifamily solar projects are challenging to finance with a PPA, as the individual solar projects have higher $/Watt-DC costs than large-commercial projects and they are too small to finance standalone. In addition, it is difficult to standardize the underwriting process for businesses/multifamily buildings, as these entities do not have a FICO score like an individual homeowner. While there are examples of PPAs for multifamily affordable housing, there are a limited number of providers and product availability is still a significant barrier, discussed further in the Drawbacks, Limitations, and Barriers section below. An example of a successful solar PPA for multifamily affordable housing follows.

Case Study: Denver Housing Authority

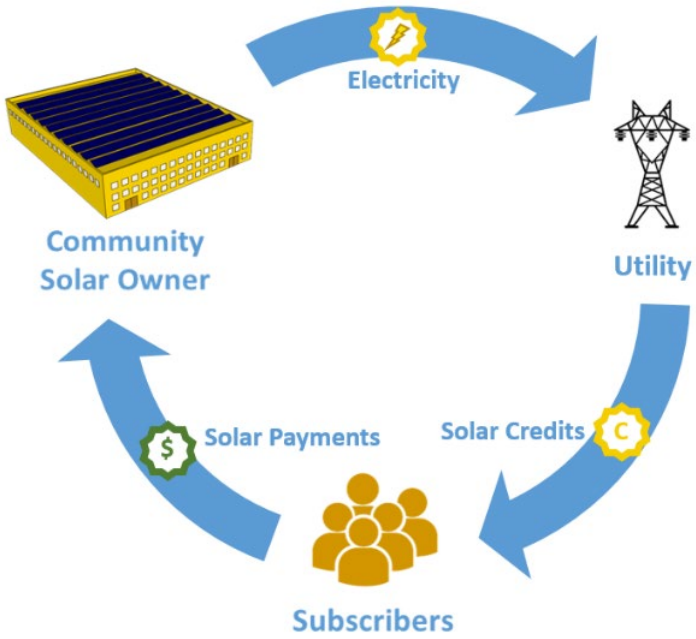
In 2013, the Denver Housing Authority completed a 2.5-megawatt scattered site rooftop solar project. The $10 million solar project was financed with a zero-down PPA, allowing the housing authority to increase its use of solar energy with no upfront cost and no increase to the authority's ongoing energy expenses.[8] The Denver Housing Authority continued to build on the success of its solar initiative. In 2018, the authority completed the development of an additional two-megawatt, ground-mounted community shared solar project, which serves the authority and other multifamily affordable housing in Colorado.

3.1.1.4 Community Solar Site Lease

Many affordable housing properties are strong candidates for solar based on their available roof area; however, they are not candidates for PPAs due to limited owner-paid electricity consumption and/or owner-paid electricity tariffs, which result in a low-value solar. Community distributed generation (CDG) is a relatively new solar credit distribution model that allows solar energy produced by a single large system to be distributed among many electric utility accounts within the same utility service area. States developed and adopted CDG in order to expand access to the benefits of solar energy among renters and others who cannot install solar on their own rooftop. CDG can be financed similarly to a standard solar PPA; however, CDG decouples the geographic location of the solar energy system and the recipients of the solar energy credits, allowing CDG projects to offset relatively high residential electricity rates with larger systems hosted on commercial rooftops or large ground-mounted solar arrays. These large systems have lower per unit ($/Watt-DC) installation costs, benefit from solar tax incentives (through third-party ownership models) and deliver high-value solar energy. This decoupling creates an opportunity for affordable housing properties with significant usable roof area to host community shared solar projects in exchange for a roof lease payment. From the perspective of a property owner, the benefits of hosting a CDG project include no capital outlay, limited liability, and recurring revenue.

Figure 10. Community Solar Diagram

Source: Solar One



In order to host a CDG project, a property must meet the following conditions:

- Regulatory approval of CDG
- Usable roof area for a large solar installation
- Ability to lease roof for 20+ years
- Low $/Watt-DC installation costs and/or
- Strong state/utility incentives

Case Study: New York City Housing Authority

In 2016, the New York City Housing Authority (NYCHA) published its Next Generation NYCHA Sustainability Agenda,[9] which detailed the public housing authority's plan to install 25 megawatts of solar PV on its rooftops by 2025. NYCHA is the largest public housing authority in the United States, providing affordable housing to more than 400,000 low-income residents, and the authority is notoriously underfunded. NYCHA receives low-cost electricity from the New York Power Authority, a public utility that provides discounted power to municipal entities in New York State. Based on NYCHA's competing capital needs and low-cost electricity supply, NYCHA developed a solar strategy that relies heavily on community shared solar hosting, thereby allowing the authority to install solar with no capital outlay. NYCHA has issued two RFPs for community solar on its rooftops, one oriented toward commercial developers and one oriented toward community groups, the NYCHA ACCES Solar program. Through these solicitations, NYCHA has awarded solar site licenses to several community solar project developers, and the authority expects the selected teams will install 10 megawatts of solar by the end of 2021.

Figure 11. NYCHA Kingsborough House Rooftops, Brooklyn, NY

Source: Solar One

Drawbacks, Limitations, and Barriers

While PPAs and CDG site leases can be a compelling option for multifamily affordable housing developments to install solar with no upfront cost, these third-party financing options are not always possible. Additionally, even when they are possible, they may not be optimal.

3.1.1.5 Challenge: Limited Availability of Power Purchase Agreements for Multifamily Affordable Housing

In markets where the regulator allows third-party ownership, there are many companies willing/able to finance large-scale solar PPAs for commercial rooftops, where the scale of the opportunity is sufficient to justify the transaction costs. Similarly, there are many companies willing/able to finance residential solar PPAs, as the solar installation and underwriting processes are standardized and streamlined. However, the multifamily affordable housing sector generally does not benefit from scale or simplicity, severely limiting the number of solar PPA providers willing to serve the market. Even in markets where there are PPA providers able to serve the market, they tend to have minimum system size thresholds

of at least 50 kilowatts-DC (roughly double the solar capacity of a typical multifamily walkup building in NYC) and often require highly competitive installation costs in order to deliver meaningful utility bill savings to the affordable housing property.

3.1.1.6 Challenge: Individual Properties Are Too Small to Be Suitable Community Distributed Generation Host Sites

While CDG decouples solar production from the ultimate recipient of solar energy credits, thereby allowing for a higher value of solar, the economics of CDG are still highly contingent on the size of the solar energy system. Unless a multifamily affordable housing property can support hundreds of kilowatts-DC of solar capacity, it is unlikely that a typical CDG developer will be willing/able to pay the property owner a solar roof lease. In some cases, aggregating many properties together can make it possible to overcome this barrier. In other cases, the sites simply will not be viable CDG host sites.

Drawback: Third-Party Ownership Can Result in Less Long-Term Benefit for Affordable Housing Provider

While zero-down financing can be a compelling proposition, and bring the benefits of tax credits into solar projects, in many cases the lifetime economic benefit that will accrue to an affordable housing property with a PPA or lease will be significantly lower than the benefit they could realize through direct ownership. The reason for this is simple: the third-party owner of the solar energy system is seeking to maximize their revenue, which they can achieve through higher PPA rates, longer-term PPAs, and escalators. PPAs should always be designed to deliver net utility bill savings to the property; however, the lifetime net savings are often fairly modest. Solar development companies justify this benefit split based on significant capital outlay they are making for the solar project. It should be noted that third-party ownership is often a property owner's only viable option, and the net savings delivered via the PPA or lease are still significant relative to business as usual.

3.1.2 Solution: Long-Term Loans

In addition to third-party financed solar products, which are unique to the industry and leverage tax credits, standard loans can also be a powerful tool to help affordable housing properties overcome the upfront cost barrier to solar adoption. Solar PV technology is reliable, and solar panels typically carry a 25-year production warranty from the manufacturer. Solar panel longevity and reliability makes long-term loans a good match for the technology. In some cases, solar can be incorporated into the scope of work and financing package for an affordable housing retrofit or new construction project. In other cases, solar projects can be financed as standalone transactions where the lender is underwriting

the utility bill savings/revenue that the solar project is forecast to provide to the borrower as well as the borrower itself. While there are many mission-driven, affordable housing lenders who are beginning to underwrite projects that include solar, there are also emerging financial institutions, and financial products, that are specifically oriented toward providing loans for solar projects.

3.1.2.1 Private Affordable Housing Lenders

Community Development Financial Institutions (CDFI) are among the most common lenders for borrowers seeking to create or preserve affordable housing. These organizations tend to offer diverse financial products for affordable housing development, including predevelopment loans, construction loans, affordable housing tax credit equity, and permanent loans. Many of these organizations have underwritten affordable housing projects that include solar PV, while others, such as Enterprise, LISC, and Community Preservation Corporation (CPC), have played a leadership role in encouraging borrowers to incorporate cost-saving energy efficiency and clean energy technologies into affordable housing. As these CDFIs gain experience financing solar projects, their loan products and underwriting methods are becoming more favorable for affordable housing projects that include solar. In some cases, the CDFIs are even participating in solar-only transactions, a positive development for standalone solar retrofits in the affordable housing sector outside of properties' typical investment cycle.

Case Study: Community Preservation Corporation

A 2017 case study published by Community Preservation Corporation (CPC)[10] shows how they incorporated solar PV and ground source heat pumps into an affordable housing preservation loan. Not only was the loan able to support the clean energy technology, but CPC was able to make additional funds available to the borrower by underwriting the utility bill savings provided by the clean energy technology. In addition, CPC published Underwriting Efficiency: A Lender Handbook[11] in 2017 for mortgage lenders on how to underwrite energy efficiency and solar projects.

Case Study: Habitat for Humanity New York City

In 2018, Solar One worked with Habitat for Humanity NYC's Community Loan Fund to provide a solar loan for an income-restricted co-op in East Harlem. The low-interest loan included the projected savings from the solar energy system in the underwriting and allowed the co-op to prepay the loan with the

savings from the first year's tax credits. With this loan, total net savings for the project was nearly the same as a cash purchase, and the projected annual solar savings are always higher than loan payments throughout the term of the loan.

3.1.2.2 Subsidized Loans from Municipal Housing Agencies

In addition to private loans, many borrowers seeking funding for affordable housing preservation and/or development will borrow from municipal housing agencies. In New York State, these entities include the New York City Department of Housing Preservation and Development (HPD), the New York City Housing Development Corporation (HDC), and the New York State Homes and Community Renewal (HCR). Each of these governmental agencies have slightly different mission statements and/or geographic areas of focus; however, they all offer affordable housing tax credit allocations, debt, and other incentives to developers creating and/or preserving affordable housing. In many cases, these municipal lenders will be just one source of capital or subsidy in a capital stack for affordable housing developments alongside private lenders. These agencies' primary objectives are creating and preserving affordable housing. However, in recent years the City and State have tasked the agencies with integrating clean energy and efficiency to support aggressive energy and greenhouse gas emissions reduction targets/mandates. These policies, combined with declining costs for solar technology, present a significant opportunity for affordable housing to leverage low-cost debt to finance solar PV.

Case Study: New York City Department of Housing Preservation and Development Green Housing Preservation Program

NYC HPD is responsible for developing and maintaining New York City's stock of affordable housing, primarily through the provision of low-cost debt and tax incentives for landlords/developers that commit to creating or preserving affordable units. Through its Green Housing Preservation Program, NYC HPD provides borrowers with low-interest, and in some cases forgivable, loans to add solar and/or energy efficiency into their affordable housing retrofits. NYC HPD has worked in partnership with Solar One to facilitate competitive procurement for solar PV on 54 affordable housing properties through the program since 2016.

3.1.2.3 Clean Energy Lenders

In addition to traditional affordable housing lenders, there is an increasing number of financial institutions whose mission is to finance clean energy projects. These institutions do not typically have the same level of affordable housing expertise and/or connections as the CDFIs and municipal housing agencies;

however, they have a greater knowledge of/comfort with the solar industry and greater expertise underwriting energy savings and financing solar projects. Examples of these clean energy lenders include the NY Green Bank, the New York City Energy Efficiency Corporation (NYCEEC), Inclusive Prosperity Capital (IPC), and the Clean Energy Credit Union. These entities tend to offer different financial products than the affordable housing lenders, including loans with planned prepayment after the receipt of tax credits and unsecured loans (or loans where the only security is a UCC filing to memorialize their interest in the solar equipment). The NY Green Bank tends to focus on large-scale (multimillion-dollar) transactions, while NYCEEC, IPC and the Clean Energy Credit Union are able to directly underwrite and finance small/midsized solar projects. The specific terms offered by these lenders can vary significantly, and their availability and suitability for a particular project depends on geographic location, project size, and the borrower's alternative options.

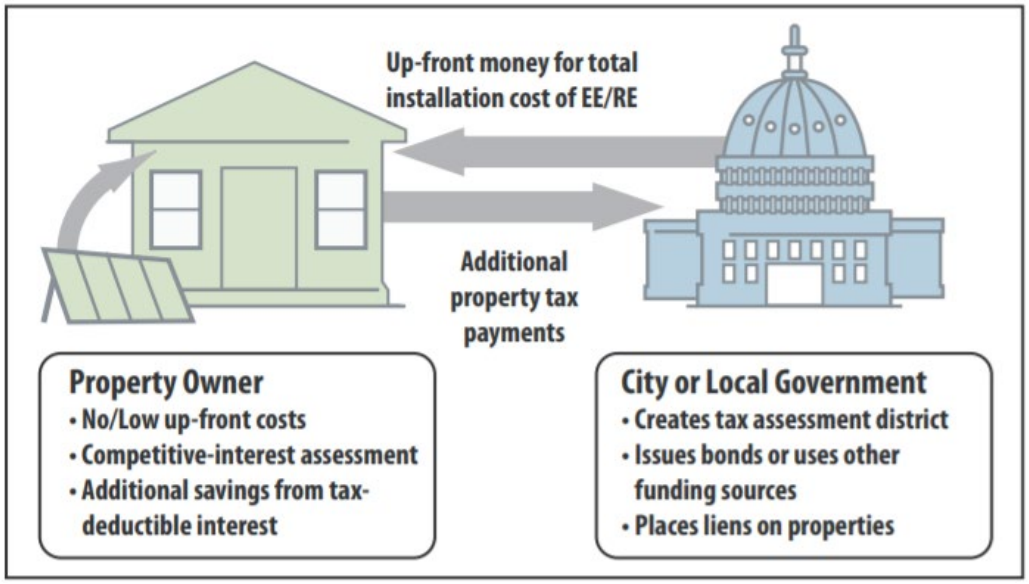
3.1.2.4 Property Assessed Clean Energy

Property Assessed Clean Energy (PACE) is an innovative financing mechanism for clean energy projects. Under PACE, loans are made for cost-effective clean energy projects and those loans are repaid over a term of up to 20 years through an assessment added onto the building owners' property tax bills. PACE provides several key benefits versus other financing options including the following:

- Longer loan terms that allow for a greater number of clean energy projects to be cash flow positive from day one.
- Reduced risk that a lender will not recoup their investment, as the municipality's assessment on the property for the solar or efficiency measure is senior to all other debts,[12] and the assessment can be transferred to another owner in the event of the original building owner selling their property.
    - This expands access to capital among nonprofit and LMI buildings because PACE allows financiers to underwrite projects with less concern regarding borrowers.
- Reduced concern of investment recovery for building owners because PACE stays with the building that benefits from the clean energy project even after transfer of ownership.
- Potential opportunity for municipalities to expand access to underserved market segments, such as affordable housing and its low- and moderate-income residents (LMI) through program design and the targeted use of lower cost capital.

Figure 12. Basic PACE Financing

Source: National Renewable Energy Laboratory



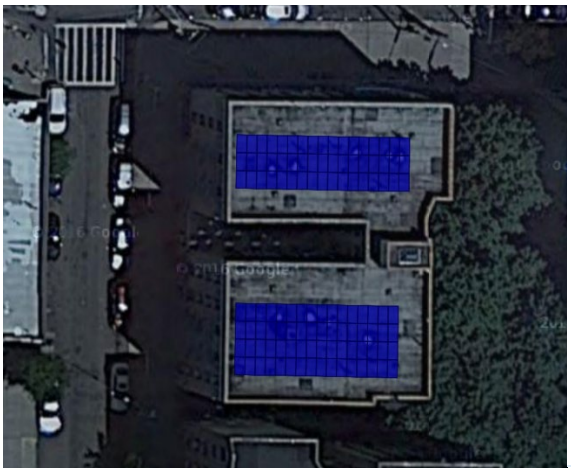
New York State enabled PACE financing in 2009 and created Energize NY, a nonprofit administrator for the State's PACE financing program. Energize NY is the administrator for all municipalities that opt-in to PACE (except NYC), and NYSERDA and Energize NY provide technical assistance to municipalities that are interested in enabling PACE for homes and businesses within their jurisdiction. In 2019, New York City enabled Commercial PACE, and tasked NYCEEC with launching the PACE program, which it plans to do in early 2020.

PACE Case Study (Sample Project Analysis)

The following case study is based on a multifamily building in the Bronx that belongs to an affordable housing developer that engaged Solar One to determine the feasibility of solar energy systems for their portfolio of multifamily buildings. The organization that owns the property is not able to monetize the federal solar tax credit (ITC) because it does not pay income taxes and it is too small to find a third-party financier.

Figure 13. Sample New York City Multifamily Solar Project Financial Analysis

Source: Solar One



Building type:	Multifamily
Location:	Bronx, NY
Ownership:	Affordable housing provider

System Size:	36 kilowatts-DC	
Year One Solar Energy Production:	43,740 kilowatt hours	
Year One Utility Bill Savings:	$	10,498
Total System Cost:	$	(135,000)
NYSUN Incentive:	$	25,200
Upfront Cost:	$	(109,800)
NYC Property Tax Abatement:	N/A	
Federal Tax Credit:	N/A	

	Equipment Loan* (7 yr)	Equipment Loan* (12 yr)	PACE (6% Interest)	PACE** (Current Energize NY Rate)	PACE*** (Energize NY QECB Reduced Rate)
Loan term (years)	7	12	20	20	20
Interest rate	4.50%	7.00%	6.00%	5.20%	3.83%
Annual loan payment****	$ 18,864	$ 13,956	$ 9,723	$ 9,107	$ 8,103
Year one net savings	$ (8,367)	$ (3,459)	$ 775	$ 1,391	$ 2,395
Immediately cashflow positive?	**No**	**No**	**Yes**	**Yes**	**Yes**
Lifetime savings	$ 204,192	$ 168,764	$ 141,784	$ 154,100	$ 174,184

**Equipment loan terms based on NYCEEC loan products as of September 2016*

***PACE financing details provided by Energize NY on 9/9/16 based on their current standard interest rate for 20yr financing.*

****PACE QECB financing details taken from an Energize NY case study for a non-profit solar project that benefited from low interest rates because the municipality used Qualified Energy Conservation Bonds for the project.*
http://energizeny.org/news/detail/energize-ny-finances-solar-panels-for-a-catholic-church#.V9GLx5grJPY

*****Annual loan payments calculated using bankrate.com loan calculator.*

For the example above, 20-year PACE financing with a 6% interest rate would enable the building to adopt solar and realize immediate net savings, even without monetizing any of the tax incentives. For affordable housing providers with tight operating margins, a proposed energy project's ability to contribute positively to cash flow from day one is critical.

3.1.2.5 Drawbacks, Limitations, and Barriers

Private Affordable Housing Lenders

Barrier: Affordable Housing Lenders Often Have Limited Knowledge or Expertise Regarding Solar Technology.

As a result, borrowers often have to expend significant time and energy to educate the lender regarding solar technology, costs, and projected benefits. Many borrowers are not willing or able to expend these resources and have more pressing priorities for their retrofit project—factors that can lead to the developer cutting solar PV from scope.

Barrier: Perceived Risk of Solar PV Results in Higher Interest Rates and/or Lower Approved Loan Amounts

Lenders' limited experience in financing solar can result in credit committees recommending higher interest rates for projects that include solar PV and/or more conservative underwriting assumptions for utility bill savings, resulting in a reduced total approved loan amount, another factor that can contribute to a developer cutting solar PV from project scope.

Municipal Housing Agencies

Drawback: High-Transaction Costs and Administrative Overhead for Borrower

Municipal housing agencies can have complicated, and sometimes arcane, processes and requirements for borrowers in order to close on financing and draw funds for a project. These entities are often an ideal lender (or the only willing lender) for large retrofits that require millions of dollars in low-cost debt or subsidy in order to be economically viable. However, smaller retrofit projects, such as solar PV installation and roof preservation, cannot support the high administrative, legal, and regulatory costs associated with loans from municipal housing agencies. The result is that affordable housing providers who are simply seeking to implement solar PV and other lower-cost retrofits often resort to private lenders with higher interest rates, or simply delay the installation of solar PV until their next planned major retrofit, which could be more than a decade in the future.

Clean Energy Lenders

Limitation: Lack of Awareness of Lenders and Product Offerings among Affordable Housing Providers

Affordable housing providers are often unaware of clean energy lenders and do not have the in-house expertise to research and evaluate the various lenders and their product offerings.

Drawback: High Interest Rates, Minimum Loan Amounts, and Short Loan Terms

Many private clean energy lenders do not have access to low-cost capital, making them a significantly more expensive option than borrowing from a municipal housing agency. Additionally, these lenders often structure their product offering to serve the commercial solar sector, where the borrower is often able to claim all the available solar tax incentives and therefore can repay a loan in seven to 10 years. However, many affordable housing properties are owned by nonprofit organizations that are unable to directly monetize the tax incentives, which means they need longer-term loans in order to achieve an acceptable debt service coverage ratio (DSCR).

PACE Financing

Limitation: Many Municipalities Have Not Yet Adopted PACE Financing, Limiting Its Availability in Many Parts of New York.

New York City will have access to PACE financing as of 2020, but the details of the program are not yet known.

3.1.3 NYSERDA Recommendations

- Convene an affordable housing solar finance working group comprised of leading affordable housing lenders, including HPD, HDC, and HCR in order to increase participants' knowledge of solar and to identify opportunities to standardize policies and processes for solar financing, underwriting, and approval of third-party financing.
- Convene regional and national solar PPA providers to gain their insights regarding barriers and opportunities in the multifamily affordable housing sector. Incorporate input into future program design and encourage their participation in this underserved market segment.
- Continue to promote the adoption of PACE financing among municipalities throughout the State.
- Leverage NY Green Bank capital to increase the availability of PPAs for the affordable housing sector, particularly small properties that have limited options, through strategic investment in intermediary lenders and financiers focused on the segment.
- Provide technical assistance, directly or through subcontractors, to affordable housing providers seeking to install solar so they can select the most suitable financing strategy.

3.2 Challenge: Affordable Housing Owners Unable to Monetize Solar Tax Incentives

While there are generous federal, state, and local tax incentives available for solar PV, many multifamily affordable housing properties are unable to benefit from these incentives as they are tax-exempt entities or have limited income, thereby restricting their ability to benefit from tax incentives. This incentive is regressive, meaning it is inaccessible to those properties in need of the incentive the most in order to adopt solar. Fortunately, third-party ownership and other creative strategies can allow nonprofits and low-income cooperatives to benefit from solar tax incentives.

3.2.1 Proposed Solutions

3.2.1.1 Solution: Zero-Down, Third-Party Financing

As discussed in the previous section, zero-down, third-party financing can allow nonprofit entities to benefit indirectly from solar tax credits. This can be a compelling option for affordable housing properties that cannot directly benefit from solar tax incentives. One drawback of zero-down, third-party financing is that the lifetime net benefit to the affordable housing property is generally lower than it is with direct ownership, as the third-party financier seeks to maximize their long-term revenue.

This drawback can be overcome through the inclusion of favorable early termination options in a solar PPA or site lease. Depending on the affordable housing provider's cost of capital, paying a third-party system owner in exchange for full ownership of the system after the tax credit recapture period (typically five to six years) can be a good strategy to increase lifetime net savings. For example, if an affordable housing property were to enter into a 20 year PPA and were to terminate the agreement after 10 years by making a payment to the PPA provider, the building owner would receive significant additional financial benefit during that 10-year period as well as during the solar energy system's five to 10 additional years of useful life. One benefit of the termination option is that it can generally be exercised at the building owner's sole discretion. A zero-down PPA with termination options allows affordable housing properties to install solar and begin saving with no capital investment while leaving open the possibility for investment and direct ownership in the future.

3.2.1.2 Solution: Prepaid Power Purchase Agreement

In addition to zero-down, third-party financing options, some solar finance companies also offer options for building owners to enter into a "prepaid" third-party owned option. With these options, sometimes referred to as "prepaid PPAs" or "prepaid solar service agreements" the building owner pays a solar company to install, own, and operate a solar energy system on their property, and pass on all the energy it generates to the building owner. However, because the solar company can monetize the tax incentives, they offer the building owner a discount, typically 15–20%, versus the cost of direct ownership, essentially sharing the benefit of solar tax credits. This structure is most appropriately compared with a cash purchase, and generally yields a payback period that is one to three years shorter and a higher ROI than a cash purchase where tax incentives can't be claimed directly.

Three companies that offer prepaid options for multifamily affordable housing include CollectiveSun, HelioPower, and most recently Sunrun. These options can be paired with loans, and depending on the building owner's cost of capital, this option generally delivers solar energy at a much lower levelized cost of electricity (LCOE) than a zero-down PPA.

3.2.1.3 Solution: Create Special Purpose Entity

Another option for the ambitious affordable housing developer is to create a special purpose entity (SPE) and to raise tax equity and debt to finance their solar project, as would be the case in a solar development company. With this approach, the affordable housing developer effectively steps into the role of the solar developer and receives the profits they would otherwise forego to a third-party with a traditional zero-down PPA. Enterprise and the National Housing Trust (NHT) offer technical assistance to affordable housing developers for solar projects with this structure; however, they charge a significant development fee and require that the total project size be at least 500 kilowatts DC. This approach works well for sophisticated affordable housing developers that have a large solar project.

Drawbacks, Limitations, and Barriers

Prepaid: Limited Financial Product Availability for Small Solar Projects

While there are several providers of prepaid PPAs, their system size requirements and geographic coverage can limit access to the product. For example, CollectiveSun has a 50-kilowatt DC minimum system size per site, HelioPower primarily operates in California/Nevada, and Sunrun can offer prepaid products for small individual buildings but is generally only willing to do so in the context of a large portfolio.

Special Purpose Entity: Minimum System Sizes and High-Transaction Costs

Creating, owning, and operating a solar SPE can be complicated and expensive. While Enterprise/NHT has developed a model for creating a solar SPE to provide technical assistance and template documents to affordable housing providers, the reality is that the minimum system sizes, legal costs, borrowing costs, and developer fees significantly reduce the model's applicability and benefit to the affordable housing owner.

3.2.1.4 NYSERDA Recommendations

- Highlight successful models for creatively bringing the benefit of solar tax incentives to multifamily affordable housing.
- Cultivate regional and national solar financiers, encouraging them to serve the New York State multifamily affordable housing sector with financial products that are broadly applicable across system size and geography.
- Consider modifying the NY-Sun incentive and other program designs to meet financiers' needs related to the segment.

4 Predevelopment and Permitting, Interconnection, and Inspections

4.1 Challenge: Lengthy Delays in Predevelopment

Commercial solar projects, especially on multifamily affordable housing, often have predevelopment stages that last for months or even years. Some of this is innate to multifamily buildings, where multiple owners, or a board of directors, need to make a collective decision. Regardless, reforms to the predevelopment process could make solar a simpler and more profitable endeavor for affordable housing. This report identifies three areas of predevelopment with potential for significant improvement: procurement, contracting, and regulatory approvals.

4.1.1 Procurement

One of the most important (and often most difficult) stages of predevelopment is procurement: soliciting bids from solar companies, evaluating proposals and selecting an installation company. Competitive procurement is a best practice for every solar project, regardless of the system type, and bulk procurement across a portfolio of properties is recommended whenever possible. However, many building owners do not have a standard procurement process and are even less likely have a solar procurement process, which has nuances specific to the sector. Solar One, the author of this report, provides procurement assistance services for building owners in New York City. However, the number of building owners that could benefit from procurement assistance vastly exceeds the organization's capacity and geographic reach. There is need for easily accessible resources for multifamily affordable housing to support solar procurement. As solar adoption increases and stakeholders gain a greater level of experience with solar technology, prospective buyers of solar should be able to find a solar installer without outside assistance, just as they would find a roofing contractor or plumber. In the meantime, procurement remains a roadblock to adoption.

4.1.2 Contracting

For commercial/multifamily solar projects, the contracting process often involves legal counsel for both parties, and the negotiations can take weeks or months before the design and permitting even begin. Even though solar engineering, procurement, and construction (EPC) services have a standardized scope of work, companies use widely varying contract templates. Contract negotiation can be reasonable

and even necessary for large, multimillion-dollar projects or portfolios; however, for smaller systems it unnecessarily increases costs and delays well before design, engineering, and installation. In Solar One's experience, the length of time spent on contracting can range from a few days to nearly a year, averaging two to three months even for small multifamily buildings with simple system designs.

Dirk Michels, one of the authors of the first commercial PPA, said, "the legal cost of negotiation could drop from approximately $20,000 and more currently for a small to medium-size behind-the-meter C&I project to considerably less than $5,000"[13] using a standardized PPA contract. While this statement was made in the context of the rollout of a standardized commercial PPA specifically, the same could be true for a straightforward commercial solar purchase.

4.1.3 Financier Approval

This final major hurdle is common among affordable housing—obtaining approval from financiers or affordable housing regulatory bodies such as HUD or HPD for third-party financed solar projects. For many affordable housing providers, any kind of capital project requires approval from the financier and that approval can take months. The approval process is designed for large retrofits, while solar installations usually only have a modest impact on residents, the property or its cash flow. The challenge of securing lender/owner consent is compounded by the fact that many are not familiar with solar installations or financing structure, resulting in inefficient approval processes.

While most affordable housing developers seek consent from lenders/regulators prior to installing solar, there is not consensus among developers/general partners/property managers whether such approval is necessary. For example, ballasted solar installations that are financed by a third-party will not require roof penetrations, capital investment or any increase to operating expenses. Some developers, and general partners, have made the case that the non-invasive nature of such a project allows them to proceed without securing lender/regulator consent. While circumstances vary, it would be beneficial for City and State municipal housing agencies to provide guidance on this question.

4.2 Proposed Solutions

4.2.1 Solution: Standardized Commercial Solar Engineering, Procurement, and Construction Services Contract

Industry standardized contracts already exist in the residential sector and for commercial PPAs and leases with great success—installers fill in system specifications and send the standard contract to the customer for signature. This could be implemented for cash purchase contracts in the multifamily sector as well

with a standardized commercial EPC contract that utilizes customer-friendly best practices for contract language but also allows for flexibility in the description of the design and installation of the system. With a standardized contract, building owners are more likely to quickly review and approve the contract, limiting legal fees on current and future solar contracting processes.

Drawbacks, Limitations, and Barriers

Limitation

For commercial projects, customization is often the norm. Commercial owners often have legal counsel and negotiate every contract, whether or not it is standard. Because of this, there are limits to the application of standardized contracts. However, we believe that for many cases, a standardized contract, created with the interests of the customer in mind, would allow a greater number of contracts to be signed expeditiously.

Limitation

Standardized contracts will only be adopted if the contract templates are developed with input from solar companies, affordable housing lenders, and affordable housing developers.

4.2.1.1 Case Study: NREL Solar Access to Public Capital

In 2013, NREL's Solar Access to Public Capital (SAPC) working group created a number of model contracts[14] that are now widely used for PPAs and leases. The templates include PPA and lease contracts for both aggregated and disaggregated projects (for installers offering their own financing or a partnership between separate installation and financing companies) in the residential sector as well as template PPAs and leases for commercial customers. These contracts are now widely used throughout the country.

Solar One has also witnessed the benefit of standardized contracts through its work providing solar technical assistance to borrowers participating in HPD loan programs. HPD requires solar installers to use a standard American Institute of Architects (AIA) construction contract. While this contract template has its drawbacks (it needs to be modified to include a standard solar project milestone payment schedule), the use of the AIA template enables solar companies to finalize and execute contracts quickly.

4.2.2 Solution: Create Resource for Multifamily Request for Proposal Templates

Standard solar RFP templates exist for many different types of customers, including templates for municipal projects, tribal lands,[15] and even an RFP developed specifically by HUD for public housing. Collecting these templates in one easy-to-access location and making them available would help multifamily buildings find an installer or run competitive bidding processes to get good pricing from a qualified contractor.

Drawbacks, Limitations, and Barriers

Limitation

Having a resource for RFP templates is only a partial solution. Building owners unfamiliar with solar terminology and practices would still need to either learn about solar or seek technical assistance. An RFP template simplifies the bidding process, but evaluating the proposals is still beyond the limits of most building owners on their own.

4.2.3 Solution: Streamline Affordable Housing Financier Approval Process

In addition to the permitting and interconnection process, affordable housing providers often need approval from their financers, regulators, and owners to proceed with a solar project. Creating a widely accepted standard approval document for affordable housing owners and parties like HUD, HPD, or LIHTC investors would reduce the wait time specifically for affordable housing. One of the main reasons the long approval process is that the financers approach solar installations like other major construction projects, while in fact solar is much less invasive. For ballasted installations that are third-party financed, the case can be made that approval is not needed at all. In most cases, it is unclear whether approval will be necessary, and it is up to the affordable housing provider to determine how to proceed: request permission in advance, inform the financer but do not wait for approval, or simply proceed with the solar project. The risk is high regardless of the approach—if the affordable housing provider asks for permission ahead of time, it may result in delays. If they elect to proceed with a solar project without securing advanced consent, the financier, limited partner, or regulator may disapprove after the fact.

4.2.3.1 Proposed Steps to Improve and Streamline the Process:

- City and State affordable housing lenders/regulators to establish clear criteria for whether (and which type of) solar projects should require approval
- City and State affordable housing lenders/regulators to develop standard solar project approval forms which capture key project characteristics of importance to a lender, investor, or regulator
- City and State affordable housing lenders/regulators and/or NYSERDA to provide resource guides and technical assistance to private financiers/investors so review and approval of solar projects can be accomplished quickly

Drawbacks, Limitations, and Barriers

Barrier

Many processes within the affordable housing sector are complex and involve large regulatory and financial institutions with their own processes and constraints. Therefore, while these entities would ideally standardize their solar approval processes, in reality it may not be feasible. As an alternative, online resources and best practice guides could be developed to support process improvements within agencies.

Case Studies/Examples

NYC HPD is the primary lender for many affordable housing projects in NYC and, over the years, the agency has become increasingly comfortable financing solar. HPD has included solar viability screening in their Integrated Physical Needs Assessment, organized trainings with their staff, used solar savings to underwrite other retrofits, and is planning to integrate solar into an increasing percentage of retrofits in the coming years. While HPD's solar efforts generally focus on refinancing/capitalization events, rather than mid-cycle, third-party financed solar projects, it demonstrates that as an entity becomes more knowledgeable about solar, the willingness to include solar in more contexts increases along with a declining amount of investigation with each contract.

Figure 14. Sample Solar Estimate from Integrated Physical Needs Assessment Tool

Source: Solar One

Solar Financial Summary		
Solar electric systems provide electricity bill savings, however they are also eligible for a number of federal, state and local incentives that can significantly improve the payback period and SIR for the building owner(s). The table below includes a summary of the estimated cost, payback period and SIR for a solar energy system on this property based on the data gathered during the IPNA.		
Estimated Maximum System Size (kW-DC)	20.0	<- Largest system that could fit on the roof
Max System Size to Offset Owner-Paid Usage (kW-DC)	**20.0**	<- Recommended system size
Year One Solar Production (kWh)	**24,300**	
Year One Solar Production Equiv (kBTU)	**82,912**	
Year One Utility Bill Savings	**$ 5,589**	
Total Cost Estimate	$ 80,000	
NYSUN Incentive	$ 14,000	
Upfront Cost Estimate	**$ 66,000**	
Payback Period (No Tax Incentives)	11 years	
Savings-Investment-Ratio (No Tax Incentives)	1.79	
Federal Tax Credit*	$ 19,800	
NYC Property Tax Abatement	$ 13,200	<- Tax abatement is spread over four years
Residential State Income Tax Credit	$ -	<-Co-op/condo only
Residential State Historic Tax Credit	$ -	<- Historic districts only
Depreciation (Federal and State)*	$ 28,544	
Federal Taxes on State Tax Credit(s)	$ -	
Cost After Incentives and Taxes	**$ 4,456**	
Payback Period	**3 years**	
Savings-Investment-Ratio	**2.68**	

4.2.4 NYSERDA Recommendations

- Convene stakeholders, including solar companies and affordable housing agencies, with the goal of developing a standardized commercial/multifamily solar EPC contract that is straightforward and meets the needs of the agencies.
- Encourage adoption of standardized documents, both the contract templates and RFP templates, whenever possible.
- Create a web page compiling standardized forms that building owners can use to procure commercial/multifamily solar, including RFP templates, standard contract templates, and educational documents.
- Create a standard request for approval for affordable housing providers installing third-party financed solar to secure lender/regulator/limited partner consent to proceed.
- Provide guidance for affordable housing developers/owners regarding the solar project approval process.
- Promote education for affordable housing lenders and financiers regarding solar energy.

4.3 Challenge: Lengthy Authority Having Jurisdiction Process

The permitting and interconnection process is complicated and expensive in the United States, and particularly in New York City. Nationwide, it is estimated that for residential systems, the soft costs associated with permitting add an average of $1.00/Watt-DC to any project,[16] and for comparable systems in urban areas, that number may be even higher. According to a 2014 NREL report on the effects of permitting on solar prices, "variations in local permitting procedures can lead to differences in average residential PV prices of approximately $0.18/Watt-DC between the jurisdictions with the most-onerous and most-favorable permitting procedures."[17] This study does not include the costs of permitting for flat roof or commercial projects.

In Solar One's experience, the combined PII timeline for flat-roofed buildings in New York City is six to eight months, while the actual solar installation may only take one to three weeks. Causes for delay can include the following:

- Unrelated building code violations that had already been addressed but the records have not been updated
- Scheduling and re-scheduling municipal and utility inspections
- Scheduling the utility meter switch after all other inspections have been completed
- The New York City Fire Department (FDNY) variance process, which requires paper submissions and can take several weeks to receive a response
- The Landmark Preservation Commission approval process which can require weeks/months and Community Board presentations in order to receive a Certificate of No Impact

In a recent study by NREL and the Rocky Mountain Institute,[18] a comparison was drawn between the permitting processes in Germany and the United States. Germany's feed-in tariff registration form is easy to fill out and projects are immediately approved or denied online. On average, German installers spend five labor hours on permitting, interconnection, and inspections per project, compared to the 19 hours spent by American installers.[19]

The lengthy permitting process delays project timelines, which can jeopardize a project's ability to benefit from a solar incentive before the incentive sunsets or steps down in value. Streamlining PII processes may be one of the most effective ways to reduce the cost of solar in New York State.

4.3.1 Proposed Solutions

4.3.1.1 Solution: Unified Permitting Process

A unified permitting process that consolidates the process of applying for utility interconnection, building and electrical permits, and the NY-Sun incentive would substantially reduce the amount of time and money solar companies spend on paperwork. To date, efforts to facilitate unified permitting processes have focused on the residential pitched-roof segment of the market. However, a unified permitting process would also be of tremendous benefit to the multifamily affordable housing sector. Ideally, such a process would include the following:

- Single application for municipal, utility, and NYSERDA approval
- Online submission and quick turnaround for simple projects that do not require detailed design review (e.g., small pitched-roof systems)
- Clear standards that any jurisdiction can use but also allow for local flexibility

New York State has developed a unified permit that AHJs around the State can use for residential pitched roof projects, and to date nearly 300 municipalities have chosen to use the standardized permit.[20] While the standardized permit is a significant improvement on the fragmented system in place before, it is just the first step towards a truly unified permitting process.

Figure 15. Sample Work Permit

Source: New York City Department of Buildings


NYC Buildings

Work Permit Department of Buildings

Permit Number: 540060128-01-EW-OT
Issued: 11/05/2014 Expires: 12/29/2014
Issued to: FABIAN WIKA
Business: 1ST LIGHT ENERGY INC
Contractor No: GC-612122
Address: STATEN ISLAND 6 MALONE AVENUE
Description of Work: CONCRETE WORK NOT AUTHORIZED - CONCRETE PLACEMENT, FORMWORK, STEEL REINFORCING NOT PERMITTED.
ALTERATION TYPE 2 - SOLAR 9.25 KW, ROOF MOUNTED, PV SOLAR ARRAY
Review is requested under Building Code: 2008
SITE FILL: NOT APPLICABLE
To see a Zoning Diagram (ZD1) or to challenge a zoning approval filed as part of a New Building application or Alteration application filed after 7/13/2006, please use "My Community" on the Buildings Department web site at www.nyc.gov/buildings.
Emergency Telephone Day or Night: 311
Borough Commissioner:
Commissioner of Buildings:
Tampering with or knowingly making a false entry in or falsely altering this permit is a crime that is punishable by a fine, imprisonment or both.

Drawbacks, Limitations, and Barriers

Barrier

AHJs have existing processes and software that they may not be willing to adjust to accommodate a relatively small sector such as solar.

Barrier

Software integration with legacy permitting systems may be highly labor intensive/expensive and therefore infeasible for small AHJs.

Barrier

Evolving AHJ requirements and AHJ desires to upgrade legacy software systems may prevent them from integrating their existing systems with new software for solar applications.

Case Study: Solar Automated Permitting Process[21]

In association with a number of solar companies and nonprofits, NREL has begun development of an open-source instantaneous online permitting process that will be standardized across jurisdictions and will allow permits to be granted instantaneously (provided the designs and plan sets meet local code). It will allow for some flexibility between jurisdictions along with clear standards that all jurisdictions can use to approve or deny permits. When implemented, this will allow municipalities to collect the same permitting fee with much less work and reduce the permitting process from weeks to minutes. Solar APP is designed for residential solar applications, but the same principles, interface, and source code could be used for small commercial and multifamily buildings. The graphic below, from Solar APP, provides their estimate of the benefits that the automated software can provide to the solar industry.

Figure 16. SolarAPP Market Potential Infographic

Source: Solar App, courtesy of The Solar Foundation[22]

4.3.1.2 Solution: Coordination of Site Inspections

In many AHJs, solar installations must be inspected up to four times: one to two times by the AHJ (electrical and construction), the utility, and a QA inspection by NYSERDA. Many elements of these inspections are redundant, not to mention time-consuming/expensive for the building owner, the solar company, and the entities completing the inspections. These inspections are often challenging to schedule and can result in long delays between solar installation and permission to operate. Coordinating simultaneous inspections, and even consolidating inspections, will reduce soft costs for the solar installers and the AHJs, thereby simplifying the process of installing solar and accelerating adoption across all sectors.

In Solar One's experience, the time between a system's mechanical completion and the receipt of its permission to operate (PTO) is one to four months—time when the system could otherwise be producing energy, were it not for inspection delays.

The following are strategies to streamline inspections include:

- Creating a single unified inspection checklist that one person could perform on behalf of multiple entities
- Combining some inspections to reduce the overall number (e.g., electrical and utility)
- Coordinating the scheduling of inspections to occur within a single day
- Foregoing on-site inspections and conducting spot inspections after installation (such as NYSERDA's NY-Sun program)
- Conducting virtual inspections with only the installer on site via video conference with the AHJs
- Waiving some inspections and relying on self-certification for smaller or simpler installations

Drawbacks, Limitations, and Barriers

Barrier

AHJs may not be willing to cede authority of approving the safety of a solar installation to another agency, even with specialized training and a shared services agreement in place.

Barrier

AHJs may not be willing or able to coordinate inspection scheduling with other agencies due to staffing constraints and incompatible software/processes.

Drawback

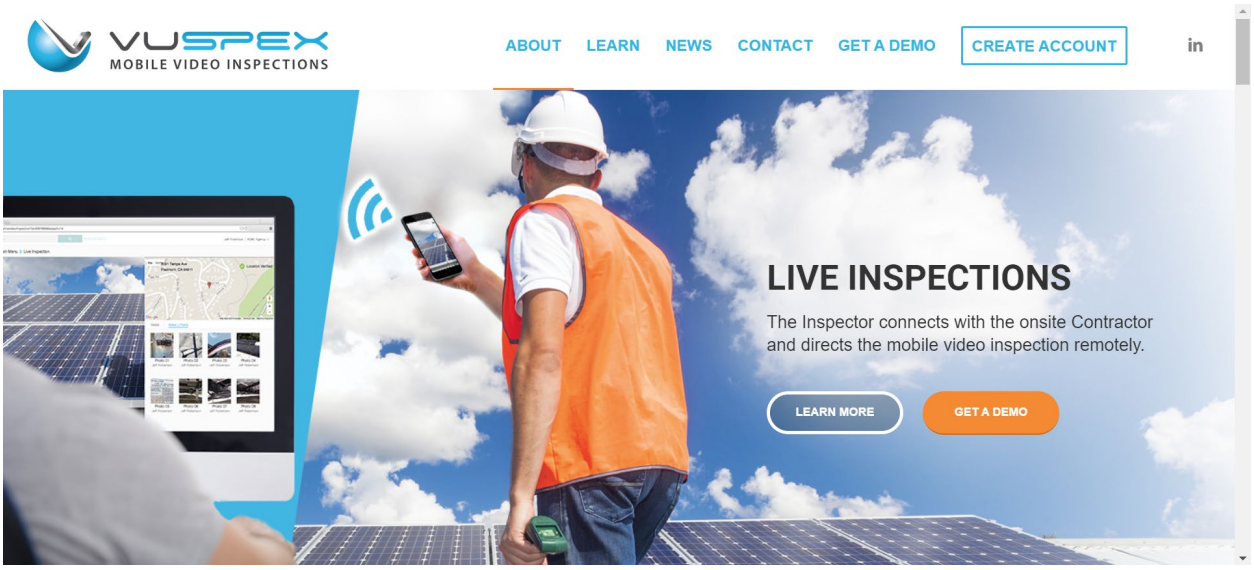
Virtual inspections may not be as rigorous as on-site inspections and may result in avoidable safety risks.

Case Study: Virtual Inspections

VuSpex is an app employed in Pasco County, Florida[23] to conduct virtual inspections by video. The installer schedules an inspection time with the AHJ, a video link is established, and the installer shows the inspector everything they ask to see and verifies with the app's geolocation that the installer is on site. The inspector is able to record pictures from the call as they go. This reduces scheduling time since only one party needs to be on site, and the inspectors can schedule more inspections per day.

Figure 17. VuSpex Remote Inspection Application Website

Source: VuSpex



4.3.1.3 Additional Considerations

Simplification of the CESIR Process

For any systems above 50 kilowatts AC, installers must complete a Coordinated Electric System Interconnection Review (CESIR), which is often costly and unpredictable. This process is important for large projects to ensure that the injection of solar electricity does not negatively affect the electric distribution system. Beyond the time involved, the costs for CESIR processes ranges from $5,000–$25,000.[24] Improving this process by improving data availability and reducing processing time and cost, would not only reduce soft costs for installers, it would make projects that are currently

stalled due to uncertainty about CESIR costs able to move forward. For further information on possible solutions, read NREL's An Overview of Distributed Energy Resource (DER) Interconnection: Current Practices and Emerging Solutions and Review of Interconnection Practices and Costs in the Western States, as well as NYSERDA's 2015 Utility Readiness Assessment for New York State.

Divest Solar Permitting from Other Construction Permits

In addition to creating a unified permitting process for solar, the other side of the coin is decoupling the solar permitting process from other construction projects, especially for the NYC Department of Buildings. Currently, a building violation in New York City can stop solar installation even if it is unrelated to the violation (e.g., an unpermitted wall modification within an apartment or an unpermitted toilet in a basement). If AHJs want to encourage solar adoption, they could waive the requirement that all other (non-safety related) violations are resolved prior to permitting a solar project.

Loosen Overly Prescriptive Solar Regulations

Some cities, New York City in particular, have stringent requirements for solar installation, including fire path setbacks that reduce the useable area for most roofs by about 30–50%. Bringing these requirements in line with best practices in other cities would significantly increase the opportunity for solar.

Standardize Permitting, Interconnection, and Inspection Best Practices

If the other suggestions are too difficult to implement, at a minimum it would be helpful to have PII best practices gathered and distributed to AHJs to make sure no localities fall behind other areas due to lack of information.

Figure 18. Affordable Housing Solar Installation in New York City

Source: Solar One

4.3.1.4 NYSERDA Recommendations

- Engage with NREL and the developers of the Solar APP to support the development of a unified permitting process that allows solar installers to submit one application to all AHJs.
    - Explore integrating NYSERDA's NY-Sun solar incentive application (via Salesforce) with Solar APP, allowing New York State to be an early adopter of the software.
    - Advocate for the inclusion of small commercial/multifamily solar projects (in addition to residential).
    - Promote Solar APP adoption among New York State jurisdictions with implementation grants and/or technical assistance.
- Provide targeted funding and technical assistance to jurisdictions willing to streamline/consolidate their solar inspection processes.
    - Encourage participating AHJs to think outside of the box and explore options like adopting a virtual inspection tool, hiring a master inspector cross-trained and authorized to sign off on solar projects for the AHJ and the utility, or other creative strategies.
- Develop and disseminate PII best-practices guides through existing relationships with municipalities and through subcontractors on programs that emphasize municipal engagement.

5 System Design and Technology

5.1 Challenge: Urban Solar Design

The fully installed cost of solar has declined significantly over the last decade, but costs have remained stubbornly high for multifamily solar projects in urban areas. The average cost of solar installations in New York City in the past three years is $4.03/Watt-DC, compared to a statewide average of $2.80/Watt-DC.[25] A large percentage of this price premium is driven by the increased soft costs associated with permitting, interconnection and inspections in urban areas, but much of it is also due to the complexity of installing solar on diverse flat roofs and labor costs.

In the residential sector, the system design process has become so streamlined that companies can use satellite imagery to measure a roof, determine the solar capacity, and create a design, without ever going to the site. The sales process can be completed in hours, and in some cases, customers can go from reading a proposal to watching the installation on their roof within a few days. None of this is t rue for multifamily solar projects. In addition to high PII costs and a complex predevelopment process, designing solar arrays for flat roofs on buildings of varying heights can present unique challenges. This section focuses on New York City as an example for urban areas with design barriers to solar. However, many of the barriers are universal, such as height and roof condition, and regulatory barriers exist in other cities as well.

Some of the biggest design challenges for solar in New York City include:

- **Fire path regulations**—FDNY requires 6-foot clear paths on every street side of a building, from front to back of each segment of the roof and connected to every door and fire escape. This significantly reduces the space available for a ballasted or planar solar array on a roof.
- **Roof obstructions**—Many flat roofs have vents, HVAC equipment, and other elements on the roof that both obstruct and cast shade, reducing usable roof area.
- **Roof lifespan**—One important issue with the installation of solar is the relationship between the lifecycle of roofs and the lifecycle of solar. Both last for 20–30 years, however often building owners decide to pursue solar partway through the roof's lifetime, leading to the issue of what to do when the roof needs to be patched or replaced but the solar is still in good condition. Currently, the only solution for major roof rehabilitation is to move or remove the panels, do the roof work, and then replace the panels, which is often costly and difficult to organize. Perhaps the largest barrier is the industry's inability to predict how much it will cost to remove solar panels in 10–15 years, should it be necessary, and that uncertainty leads to the decision to forego solar installation entirely.

- **Conduit run costs on tall buildings**—One costly element of a solar installation on midrise and high-rise buildings is running conduit from the roof to the electrical room in the basement. For taller buildings the costs of the wire, the conduit, equipment, and labor to install the conduit on the building (which often includes drilling through floors or installing brackets into the walls from stairwell or apartment windows), can increase substantially as a building height increases. In some cases, there is already conduit leading to the roof, which reduces the costs, but that is rare.
- **Crane costs for tall buildings**—For taller buildings, getting materials to the roof can be one of the biggest challenges. If the installer is not able to use a freight elevator to carry materials, tens of thousands of dollars may be required to rent, permit, and operate cranes, which often also require street closures, additional insurance, and specialized staff.

Many of these issues have no clear solution, but there are some ways to work around them, and reducing these costs could be a game changer for multifamily affordable housing, which tends to be concentrated in urban areas and therefore bears the brunt of high costs for solar.

5.2 Proposed Solutions

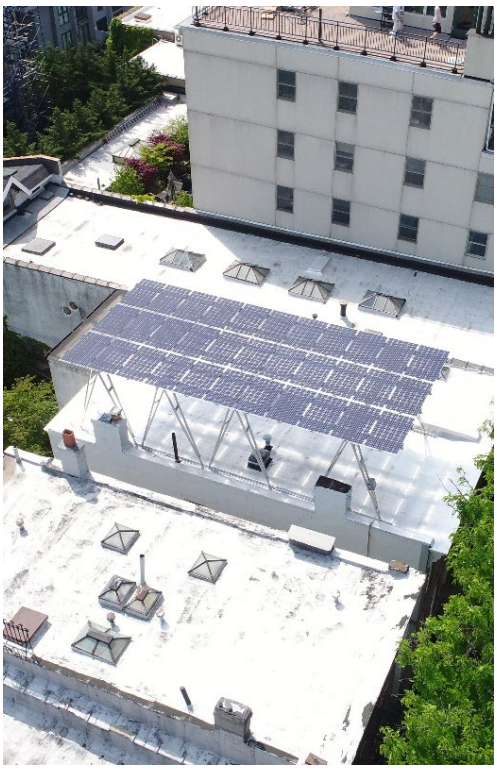
5.2.1 Solution: Lower Cost Solar Canopy

Solar canopies (i.e., solar arrays lifted 9–10 ft above the roof surface) are often the best way to take advantage of space on a flat roof, especially when the building owner is targeting net zero. An elevated array eliminates complications with FDNY requirements, roof obstructions, and roof lifespan. The issue is that current pricing for solar canopies is significantly higher. In Solar One's experience, canopies are approximately 15–20% more expensive than comparable standard solar arrays. Adoption of solar canopies will increase as costs decline. Strategies for cost reduction include the following:

- design standardization
- lower cost materials
- and increased market competition

Figure 19. Urban Solar Canopy with Bifacial Modules

Source: Brooklyn SolarWorks



Adding a solar canopy not only allows for a larger system size on a roof; it also allows roof work to take place underneath, so a building with a mid-cycle roof could install a canopy without affecting the roof replacement and repaid schedule. Additionally, canopy installations also open up roof space for future use, for example green roofs or roof decks with built-in shade and some rain protection.

Drawbacks, Limitations, and Barriers

Barrier

Lowering the cost of canopies is primarily a technical challenge, making lower cost materials and standardized designs among the most importance.

Drawback

There have been cases of newly constructed solar canopies shading previously installed ballasted systems on a neighboring building. As canopies become more common, regulations to maintain equitable solar access for existing solar energy system owners may be necessary.

Limitation

Solar canopies inherently require more hardware and installation labor than ballasted solar arrays. Therefore, while cost reduction is possible, and recommended, solar canopies will never reach cost parity with standard solar arrays.

5.2.1.1 Case Study: Brooklyn Solar Canopy

Brooklyn Solar Canopy has developed a proprietary canopy design using aluminum to reduce weight and a standard size made to fit most Brooklyn brownstone homes. While this design is still very expensive, the approach—standardizing the array by focusing on one housing type to reduce design costs, reducing the weight of materials, increasing production to achieve scale—can be replicated. Other solar companies that operate in NYC are working on similar standardized designs; however, there is not yet consensus on an industry standard and creating that would likely be the single most achievable solution to flat roof solar.

Figure 20. Solar Canopy on Affordable Housing Cooperative in Brooklyn, NY

Source: Brooklyn SolarWorks

5.2.2 Solution: Designing Solar PV to Account for Planned Roof Maintenance

Currently there is no complete answer to the issue of the mismatch between the roof lifecycle and the solar lifecycle. While there is no ideal solution to address this challenge, there several partial solutions that may help overcome this barrier in particular circumstances:

- Solar canopies can allow for roof replacement underneath PV. Canopies, whether affordable or not, are not always possible on every building, and depending on the underlying roof structure and design, they may not fully solve the issue of roof replacement.
- Solar installers can collaborate with or integrate their business model with roofing contractors to deliver a combined roof preservation/solar installation package. The integration of solar and roofing businesses has several other potential benefits.
- Cost-effective roof preservation solutions. If solar companies were able to offer cost-effective roof preservation options, such as the application of a new layer of roofing, a spray polyurethane foam roof, or even an elastomeric coating, this could significantly extend the life of the roof. Bringing the life of the roof into alignment with the lifecycle for the solar panels would eliminate the need to remove and reinstall solar panels in the future, reducing the lifetime cost of ownership. A challenge with this approach is that many building owners will be unwilling to shoulder the cost of roof preservation if their roof is in good condition by mid-cycle. Depending on the total cost of the solar and roof work, various financing options could allow the project to proceed while still delivering a net profit to the owner(s).

5.2.3 Solution: Cost-Effective Electrical Tie-Ins on Tall Buildings

One possible solution to the issue of expensive conduit runs for tall buildings is to intertie the solar to an electrical load center in an elevator service room on the roof or a top floor. There are code and metering considerations to address with this approach; however, it can reduce costs significantly. Expanding this solution to more elevator buildings would allow taller buildings to install cost-effective systems.

Another more direct solution is to require newly constructed buildings to include conduit to the roof to prepare for future solar installations. A number of jurisdictions have mandated this, most famously California in 2013, where conduit run and unobstructed roof space is mandated for new construction.[26] Having conduit preinstalled means the solar installer only needs to run the wires to the basement, instead of installing conduit on the outside of the building or in an abandoned trash chute, etc. In new buildings with elevators, the elevator room load center could be oversized to accommodate future solar installation as well, solving both these issues.

Drawbacks, Limitations, and Barriers

Barrier

Electrical code typically requires a disconnect switch for the solar PV to be co-located with the main service panel for a building, which is commonly in the basement. Therefore, developing a rooftop tie-in strategy will require creative solutions for regulatory compliance.

Barrier

Under Value of Distributed Energy Resources (VDER), the value of solar energy for multifamily buildings is often higher when electricity is exported to the grid rather than consumed behind the meter. A rooftop tie-in strategy is behind the meter by definition, which could reduce the $/kWh value of solar. One way to overcome this barrier would be "series metering," an approach where the solar output would be metered separately by the utility and the production would be added back into the bill for the pre-existing common area meter before the VDER monetary credits are applied to the bill. This would require approval of the New York Public Service Commission, technical and accounting accommodation by the utility, and may be too niche of an issue to warrant their focus.

Limitation

While "solar ready" new construction mandates will solve the issue for new buildings, most solar will be installed on existing buildings, and unfortunately there is no easy solution for running solar PV conduit on existing tall buildings.

5.2.4 Additional Considerations

5.2.4.1 Zoning Regulations

Zoning regulations in NYC currently limit the installation of solar canopies on roofs that have already exceeded their maximum height. A change in zoning regulations would allow more canopies in the city.

5.2.4.2 Building Integrated PV

Building Integrated Photovoltaics (BIPV) is an emerging solution to the high cost of solar for new construction buildings. BIPV is currently only an option for new construction or substantial renovation projects, because by definition the PV must be a structural element of the building. Examples of BIPV include solar panels as glass curtain wall, solar shingles and transparent or translucent solar as windows.

The theoretical possibility of BIPV is strong, and an improvement in technology and scaling of the industry would solve most of the issues currently faced. However, the high cost and low-energy yield of BIPV makes it hard to justify as part of a construction project, particularly for affordable housing where items that would be nice to have can come at the expense of additional units or get cost engineered out. Several solar companies, as well as the national labs, are doing research on improving BIPV technology. An increase in the value of solar and municipal solar mandates could make projects that are not currently financially feasible possible, which would allow the market to expand and achieve economies of scale.

5.2.4.3 Emerging Solar Technology

New ways of creating PV electricity are under development, including flexible or even transparent thin-film solar, Perovskite PV, Organic PV, Quantum Dot PV, and more. All of these share the problems and opportunities of BIPV in that they are very expensive and produce relatively little power per square inch. The same opportunities of technological breakthroughs and economies of scale with a higher value of solar could make these technologies viable in the future and NYSERDA could collaborate with national labs on supporting this technology's development and commercialization when feasible.

5.2.4.4 Energy Storage

Solar is vital to a renewable energy future, but without energy storage, solar cannot scale beyond a few percent of the total electricity supply due to its intermittent nature. In New York State, solar panels generate significantly more power during the summer than the winter, and all solar panels stop producing power at night. Energy storage is a key element in any kind of significant solar development, by allowing energy generated in the middle of a summer day to be stored for use in the evening. While battery storage faces significant hurdles of its own, it is a necessary solution to the intrinsic problem of solar intermittency.

5.2.4.5 Solar-Ready Buildings

In addition to leaving usable roof area for solar PV and pre-installing conduit, another element of solar-ready buildings is oversizing the service panel to allow for interconnecting solar behind the meter without upgrading the service panel. Requiring newer buildings to account for solar installations as they oversize the service panels would help facilitate future solar adoption.

5.2.4.6 NYSERDA Recommendations

- Encourage solar-ready mandates for new construction through existing programs that engage municipalities to advance sustainability.
- Collaborate with national laboratories, solar companies, universities, and incubators to support emerging solar technologies that promise to reduce costs in the future, including low-cost canopies and BIPV.
- Encourage solar installers to collaborate with roofing contractors, as appropriate.

5.3 Challenge: Solar Crediting Mechanisms Limit Incentive to Maximize Solar

New York State's current methodology for solar utility crediting encourages building owners to install enough solar capacity to offset up to 100% of their annual electric bill. However, for a building with a large roof area and low owner-paid electricity consumption, this creates a disincentive for the owner to maximize the use of their roof with a large solar array. The impact of this disincentive is even greater when one considers the lower $/Watt-DC costs that can be achieved for larger solar arrays, and the result is that many multifamily building owners decide not to install solar due to the modest financial benefit associated with small systems.

One solution to this problem is using Community Distributed Generation (CDG), either on or off site to maximize the system and distribute the credits to the residents of the building as well as the common area. However, this raises another problem, the split incentive dilemma that is common for energy efficiency retrofits: the building owner cannot easily recoup savings realized by the residents on their individual electricity accounts, so there is little or no incentive for the building owner to invest in a larger solar energy system for on-site CDG.

5.4 Proposed Solutions

5.4.1 Solution: On-Site Community Distributed Generation

On-site Community Distributed Generation (CDG) is a new model that can allow multifamily buildings to install solar energy systems on the roof in order to offset the common area costs as well as a portion of each resident's electricity bill. On-site CDG allows buildings to maximize their rooftop solar capacity, as the total electricity consumption in a multistory building typically exceeds the maximum potential solar production. On-site CDG allows buildings like co-ops and condominiums to use solar as an amenity

which directly benefits the shareholders, instead of just reducing the operating costs for the building. On-site CDG raises the issue of split incentives; however, for owner-occupied buildings this is a challenge that can be addressed, and on-site CDG is gaining popularity in the multifamily owner-occupied market segment.

Another significant benefit to on-site CDG is that the value of solar is significantly higher for credits distributed to residential electricity accounts rather than offsetting the large commercial rate. In Con Edison territory, buildings installing solar can effectively double the value of solar energy generated on site by using CDG to offset the common area and residents' bills.

Solar One has worked with both co-ops and rental buildings to use on-site community shared solar to increase the size and value of solar. For many buildings, solar can save residents 10–30% on their annual electric bills, and on-site CDG solar projects can have an overall payback period of only three to five years instead of a 10+ year payback with a smaller system just for the common area. The improved ROI for on-site community shared solar versus offsetting the common area electricity bill has been a determining factor for multiple buildings to proceed with solar installations in the last few years.

Figure 21. Sample CDG Credit Allotment for a Cooperative with On-Site CDG

Source: Solar One

Community Distributed Generation Summary

Host

Account [redacted] – SC 002

Customer Name	Allocation %	Service Class	Value Stack Credit	Status	From Date	To Date	ConEd Bill	ESCO Charges	Actual Billed Dollars	Actual Billed kWh	Credit Applied to Account
[redacted]	2.57%	901	$18.09	ACTIVE	5/16/2019	6/17/2019	$60.82		$60.82	179	$ 18.09
	2.56%	1	$18.02	ACTIVE	5/16/2019	6/17/2019	$73.53	$38.41	$111.94	413	$ 18.02
	2.56%	1	$18.02	ACTIVE	5/16/2019	6/17/2019	$60.13		$60.13	176	$ 18.02
	2.57%	901	$18.09	ACTIVE	5/16/2019	6/17/2019	$55.53		$55.53	156	$ 18.09
	2.56%	1	$18.02	ACTIVE	5/16/2019	6/17/2019	$58.05		$58.05	167	$ 18.02
	2.57%	1	$18.09	ACTIVE	5/16/2019	6/17/2019	$67.10	$49.52	$116.62	367	$ 18.09
	2.56%	1	$18.02	ACTIVE	5/16/2019	6/17/2019	$97.80	$79.21	$177.01	587	$ 18.02
	2.56%	1	$18.02	ACTIVE	5/16/2019	6/17/2019	$54.60		$54.60	152	$ 18.02
	2.57%	1	$18.09	ACTIVE	5/16/2019	6/17/2019	$50.42	$33.19	$83.61	246	$ 18.09
	2.56%	1	$18.02	ACTIVE	5/16/2019	6/17/2019	$35.55		$35.55	69	$ 18.02
	2.56%	1	$18.02	ACTIVE	5/16/2019	6/17/2019	$90.55	$72.20	$162.75	535	$ 18.02
	2.57%	901	$18.09	ACTIVE	5/16/2019	6/17/2019	$44.27		$44.27	107	$ 18.09
	2.57%	1	$18.09	ACTIVE	5/16/2019	6/17/2019	$53.16	$45.39	$98.55	267	$ 18.09
	2.56%	901	$18.02	ACTIVE	5/16/2019	6/17/2019	$65.85		$65.85	201	$ 18.02
	2.56%	901	$18.02	ACTIVE	5/16/2019	6/17/2019	$42.44		$42.44	99	$ 18.02
	2.57%	1	$18.09	ACTIVE	5/16/2019	6/17/2019	$97.96		$97.96	338	$ 18.09
	2.56%	1	$18.02	ACTIVE	5/16/2019	6/17/2019	$49.91	$32.66	$82.57	242	$ 18.02
	2.57%	901	$18.09	ACTIVE	5/16/2019	6/17/2019	$98.21		$98.21	339	$ 18.09
	2.56%	1	$18.02	ACTIVE	5/16/2019	6/17/2019	$78.71		$78.71	257	$ 18.02
	2.56%	901	$18.02	ACTIVE	5/16/2019	6/17/2019	$86.25		$86.25	289	$ 18.02
	2.57%	1	$18.09	ACTIVE	5/16/2019	6/17/2019	$75.26		$75.26	242	$ 18.09
	2.56%	1	$18.02	ACTIVE	5/16/2019	6/17/2019	$41.30		$41.30	94	$ 18.02
	2.56%	1	$18.02	ACTIVE	5/16/2019	6/17/2019	$62.24	$55.87	$118.11	332	$ 18.02
	2.56%	1	$18.02	ACTIVE	5/16/2019	6/17/2019	$136.44		$136.44	499	$ 18.02
	2.57%	1	$18.09	ACTIVE	5/16/2019	6/17/2019	$59.90		$59.90	175	$ 18.09
	2.56%	1	$18.02	ACTIVE	5/16/2019	6/17/2019	$68.41		$68.41	212	$ 18.02
	2.56%	1	$18.02	ACTIVE	5/16/2019	6/17/2019	$68.15		$68.15	211	$ 18.02
	2.56%	901	$18.02	ACTIVE	5/16/2019	6/17/2019	$71.11		$71.11	224	$ 18.02
	2.57%	1	$18.09	ACTIVE	5/16/2019	6/17/2019	$109.40		$109.40	386	$ 18.09
	2.56%	1	$18.02	ACTIVE	5/16/2019	6/17/2019	$45.45		$45.45	112	$ 18.02
	2.56%	1	$18.02	ACTIVE	5/16/2019	6/17/2019	$55.75		$55.75	157	$ 18.02
	2.57%	1	$18.09	ACTIVE	5/16/2019	6/17/2019	$88.89		$88.89	300	$ 18.09
	2.57%	1	$18.09	ACTIVE	5/16/2019	6/17/2019	$51.35	$47.66	$99.01	253	$ 18.09
	2.57%	1	$18.09	ACTIVE	5/16/2019	6/17/2019	$62.92	$59.84	$122.76	337	$ 18.09
	2.56%	1	$18.02	ACTIVE	5/16/2019	6/17/2019	$42.00		$42.00	97	$ 18.02
	2.56%	1	$18.02	ACTIVE	5/16/2019	6/17/2019	$142.86		$142.86	526	$ 18.02
	2.57%	901	$18.09	ACTIVE	5/16/2019	6/17/2019	$57.59		$57.59	165	$ 18.09
	2.57%	1	$18.09	ACTIVE	5/16/2019	6/17/2019	$70.00		$70.00	219	$ 18.09
	2.56%	1	$18.02	ACTIVE	5/16/2019	6/17/2019	$35.20	$30.42	$65.62	129	$ 18.02

5.4.2 Solution: Off-Site Community Distributed Generation

Off-site CDG is a different kind of solution to the problem of solar crediting. With off-site CDG, solar energy credits can be available to anyone who pays an electric utility bill—buildings that are completely shaded, renters, co-op members with an unresponsive board, businesses who lease space, etc. Off-site CDG is the most common community solar model, under which large-scale solar farms are constructed in fields and on warehouse roofs and the solar energy credits are sold to subscribers at a modest discount. However, off-site CDG can also apply to multifamily buildings, in a few different ways:

- Subscriptions for residents. If a building decides to install solar for their common areas, it presents a great opportunity to promote CDG to residents as a way they can opt to support local clean energy and reduce their expenses.
- CDG hosting. Buildings with available space (either a large roof or nearby land) can lease their space to a solar developer to build and manage a CDG project, allowing them to support solar and receive a lease payment for hosting solar and without any upfront investment.

NYSERDA's Solar for All initiative is an impactful program supporting CDG for low-income participants, through which NYSERDA serves as an anchor tenant for large CDG projects and distributes free solar energy credits to income-qualified households. This program could compliment the mission of affordable housing providers seeking to maximize the impact of their solar investment. However, the program is still small and difficult to qualify for, as NYSERDA requires a system to be shovel-ready before applying to the program, so there are still very few Solar for All projects in the State, and none in New York City, a region with the largest concentrations of low-income renters in the State.

Drawbacks, Limitations, and Barriers

Drawback: Prevalence of Extractive Financing Model

While off-site CDG can solve many issues for both the host and the subscribers, the third-party financed model often draws off monetary benefit to third parties like tax credit investors, lenders, customer management consultants, etc. The standard CDG contract offers subscribers a 10% discount on the value of solar energy credits, and roof lease payments are generally modest. The off-site CDG model is the fastest growing segment of the solar industry in the State, which is a boon for the environment and NYSERDA's ambitious clean energy targets. However, in its ideal form, off-site CDG would maximize community benefit, perhaps via nonprofit or community ownership, so the benefit can accrue primarily to the subscribers and hosts rather than intermediaries.

Barrier: Complexity

Most New Yorkers do not understand CDG, and neither do critical stakeholders such as affordable housing providers and financiers. The complexity of designing and executing an on- or off-site CDG project is a barrier to adoption.

5.4.3 Solution: Master Metering Conversion

Master meter conversion has long been presented as a solution to address the issue of split incentive among landlord and tenant for solar and efficiency. By combining all the accounts in the building into one master meter and submetering the individual apartments, the building owner can charge residents for their electricity usage while separately implementing distributed generation to reduce the building's owner-paid electricity bill.

Until April 2019, the value of solar ($/kWh) for master metered electric customers such as these buildings was quite low under New York State's VDER rate structure, because they were not eligible to receive the Market Transition Credit (MTC) portion of the value stack. However, in April 2019, the New York Public Service Commission issued new rules for VDER that significantly increased the value of solar for master metered residential customers by eliminating the MTC and replacing it with a "Community Credit" worth $0.12/kWh in Con Edison territory (for example) and specifically allowing master metered customers to receive the Community Credit. The Community Credit is additive to the VDER value stack, resulting in $/kWh values of greater than $0.20/kWh in Con Edison territory.

This change to VDER makes master metering a strong option and a viable solution to the split incentive dilemma. The following are some scenarios where master metering conversion could be advisable:

- The common area load is too small to utilize the solar capacity of the roof
- The common area peak demand is too high to use the majority of the solar credits through CDG (only 40% of the credits can be allocated to an account with a peak demand > 25 kW-AC)
- The benefit to the residents would be negligible individually but large in aggregate
- The master metering conversion would be financially beneficial regardless of the value of solar, due to lower electricity rates, reduced meter reading fees, and the opportunity to participate in demand-response programs, etc.

Drawbacks, Limitations, and Barriers

Drawback

Master metering conversion is expensive and is often only worthwhile for a large building with a solar PV system. In some cases, the cost of master metering conversion would outweigh the benefits of the higher value of solar and the savings with sub metering.

Barrier

Master metering conversion is complex, and if the building owner is not capable of, or interested in, taking on the responsibility, and is unwilling to pay a submetering company to administer it on their behalf, it is better to remain with direct metering from the utility.

Case Studies: RetrofitNY

Riseboro and Chris Benedict RA are pursuing this strategy of master metering + solar as part of their RetrofitNY project. Based on Solar One's experience and the RetrofitNY final report, the benefits of master metering could include increased visibility of individual apartment usage for the building owner, distribution of a portion of solar benefits to tenants, reduced electrical service charges, and potentially an increased value of solar.

Rock Property Management Company/King & King also considered master metering as part of the RetrofitNY project, but ultimately determined that the cost of the conversion outweighed the long-term benefits. From the RetrofitNY teams alone, it is clear that master metering can provide valuable benefits but is only feasible in some cases.

5.4.4 Additional Considerations

- Decouple Bill Offsets from Economic Benefit of Solar—Decoupling bill offsets from the economic benefit of solar is one way to address the limits of the current payback mechanism for solar in NYS. The simplest approach would be to establish a feed-in-tariff, where a solar energy system owner would simply be compensated at a predefined rate ($/kWh) for all solar energy generated.

5.4.5 NYSERDA Recommendations

- Encourage affordable housing providers to take advantage of on-site and off-site CDG and master metering through educational resources, workshops, and targeted technical assistance.
- Expand the Solar for All program to support the development of CDG.
  - Reduce the complexity and requirements for entering Solar for All.
- Encourage the PSC to allow for more flexibility in solar crediting with CDG, including:
  - Allowing one account to receive credits from multiple sources.
  - Allowing off-site community solar to serve fewer than 10 subscribers.
- Develop tool for building owners and developers to evaluate the cost/benefit of master metering conversion.

6 Operations

6.1 Challenge: Lack of Coordination between Related Industries

While specialization can lead to improved efficiency for closely coordinated tasks, such as automotive assembly, in the building industry there are inefficiencies that exist due to businesses specializing in only one aspect of building retrofits and limited coordination of these specialty trades. These inefficiencies have an impact on business efficiency/cost, technological solutions implemented, and customer experience.

On the business development side, "specializing" means that the building industry as a whole is duplicating efforts for customer acquisition. Generating leads, educating customers, and closing deals is expensive. If a company can deliver two or more related products, the relative cost of customer acquisition decreases, and so should the total cost for the client on a per product basis. Additionally, for work that requires obtaining building permits, companies can improve efficiency and reduce costs by coordinating design/permitting activities.

Beyond just the cost of the product, clients spend time and money bidding out distinct types of work to multiple contractors, negotiating multiple contracts, and dealing with a range of problems that arise from lack of coordination. On the technical side, new construction and building retrofits that happen independently of solar are not "solar ready," which can result in unnecessary labor for the installer to investigate the roof in order to engineer a solar PV system safely and correctly as well as deal with design challenges for siting solar panels, inverters, and conduit, etc.

6.2 Proposed Solutions

6.2.1 Solution: Business Model Integration

Business model integration is an opportunity to reduce customer acquisition costs and labor costs by coordinating related but typically disassociated industries.[27] One example is the merging of roofing and solar EPC services. If a solar company can offer roof repairs and rehabilitation, it can acquire customers who might otherwise decline a proposed solar project due to issues with their roof. The cost of customer acquisition is reduced because both approaches to sales (either through roofing or solar EPC services)

can serve as a pipeline for the other portion of the business. Another benefit is that coordination between a solar company and roofer to ensure that the installation does not void the existing roof warranty is simplified. The total cost may be reduced even further, as the business owner may be willing/able to compress their profit margins and contingency to win a large contract.

As mentioned previously, timing roof replacement with solar installation offers several benefits, including lower total cost of ownership, and opportunities for design optimization such as learning more about the existing roof structure during a tear off and modifying the solar design accordingly. Additionally, it is simpler to secure a roof warranty continuance after installing solar when the two activities are coordinated or completed by the same company.

Another logical type of business model integration is between solar and the various industries involved in new construction. Architects should be versed in solar enough to be able to at least design solar ready buildings, and at best, design the solar PV systems that will be built and include them in the scope of the project. Similarly, the engineer for a project should be able to assess whether the building and solar PV system as designed are compatible in terms of the roof's ability to support the system. Lastly, general contractors should be able to confidently bid out solar in the manner that they bid out all the tasks related to new construction.

Figure 22. Mechanically Attached Commercial Rooftop Solar Array

Source: GAF

Drawbacks, Limitations, and Barriers

Drawback

Managing two (or more) types of businesses can decrease the benefits that come from specialization—such as quality, the ability to focus on innovation, and more.

Barrier

Certain trades do not make natural partners based on work type and timeline. For example, roof work and solar are dissimilar in terms of level of electrical complexity. Cross training staff may negatively impact efficiency and/or workmanship.

Case Study: SunPower

Sunpower, a PV manufacturer and installer, collaborates with 10 of the 13 largest home building companies in California to coordinate solar on new construction.[28] Richmond American Homes states that Sunpower provides marketing support in its sales centers to enable the company to sell the idea of solar to the buyers of the new buildings.[29]

Case Studies: Bright Power and Best Energy Power

In New York City, two prominent solar companies have integrated solar with other offerings directly related to that industry. One example is Best Energy Power (BEP), which has a focus on renewable energy and other industries, including roofing.[30] The goal of BEP is to be a "one stop shop" for solar. When customers need a new roof, BEP can offer roof replacement/preservation and solar PV in one package. Bright Power, a provider of energy and water management services, has integrated solar with a variety of efficiency measures and offers consulting across a range of different building solutions. After providing a full energy audit, Bright Power can offer a comprehensive rehab, including efficiency measures, benchmarking, and solar all as one package.

6.2.2 NYSERDA Recommendations

- Interview solar companies participating in the NY-Sun program to learn more about their business models.
    - One approach would be a survey of roofing companies in various locales to determine their interest in and experience with marketing solar to their customers.
    - NYSERDA could also use Sun Power as a model and consult with them on their approach to the development of partnerships.

- Develop a matchmaking program to foster relationships between companies in related industries, with the goal of expanding solar and other green retrofits in a way that is more cost-effective and streamlined.
- Engage with large roofing manufacturers to explore the creation of solar divisions and/or partnerships.

6.3 Challenge: High Costs for Small and Individual Projects

EPC pricing is substantially higher for small and individual projects due to many factors. First, there are fixed costs that must be covered regardless of the size of the project, including contract negotiations, engineering, and PII. The larger a project, the more these costs are distributed, becoming a smaller percentage of the total EPC price.

Another element that contributes to EPC pricing for smaller solar projects is the contingency and profit margin that installers build into their price to account for the lack of predictability of workflow and the combined profit potential for a transaction. If an installer does not know how much work is coming down the pike, or a project's total dollar profit is modest due to its scale, the tendency is to inflate the pricing on the projects. This behavior can change significantly when an installer has a contract for a large initiative that spans months if not years.

6.4 Proposed Solutions

6.4.1 Solution: Bulk Procurement within Affordable Housing Portfolios

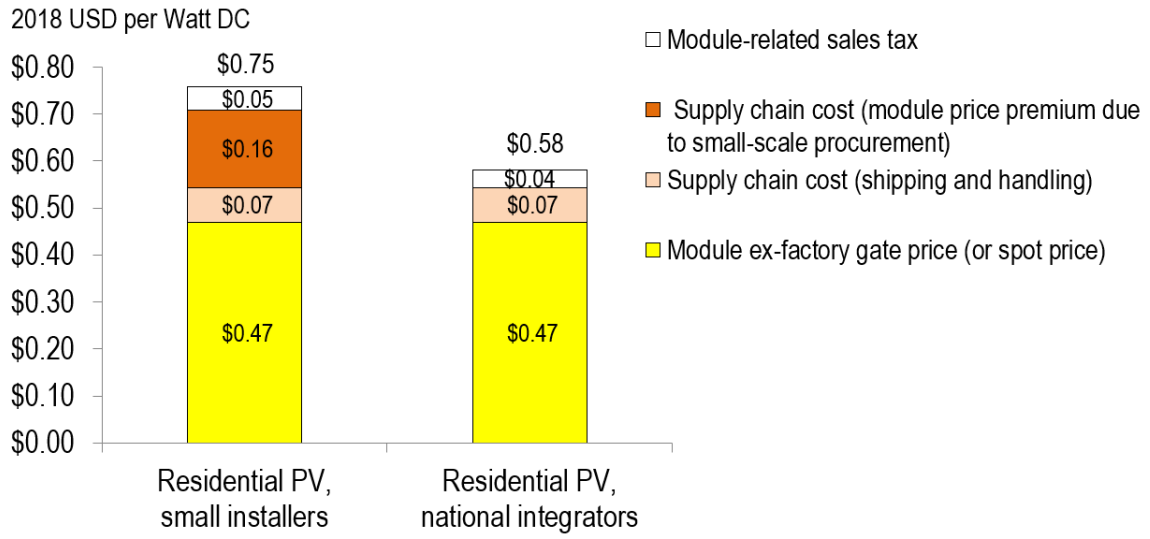
Bulk procurement can be employed when one housing provider bids out multiple buildings at one time, and is commonly used in many industries, including solar. Bulk procurement yields lower pricing for a few reasons:

- Operational efficiencies are increased, and therefore installers can offer a lower EPC price.
- Total revenue potential for a respondent to an RFP is greater with bulk procurement, so they can accept lower profit margins on a percentage basis.
- The increased scale of the initiative attracts more proposals, which typically yields a greater range of pricing, and gives the client leverage in negotiating pricing with the preferred installer. Installers are typically more willing to offer competitive pricing and make concessions during negotiation when a large project is on the line and they know that they are competing against multiple installers.

Bulk procurement delivers cost savings across the supply chain. For example, according to NREL's recent analysis, small solar installers typically pay a 29% premium for solar modules versus large national solar companies who can leverage bulk procurement. Bulk procurement for solar PV systems at the end customer level yield lower prices because solar installers are able to leverage the scale of the project to compress costs throughout the supply chain.

Figure 23. United States Solar Module Pricing Per Watt-DC by Sector

Source: National Renewable Energy Laboratory.[31]



Affordable housing providers are well-positioned to use bulk procurement. By identifying the roofs with the best potential for solar in a portfolio and bidding them out in groups, affordable housing portfolios can get reduced costs. One strategy for cost reduction is to gather a group of buildings for an initial RFP and include in the solicitation that the portfolio owner is looking to form a long-term partnership with the selected installer. This can reduce prices both in the initial RFP and for future projects with the selected installer, along with the other efficiencies associated with a partnership between a single installer and a building portfolio.

Ideally, large government entities that use bulk procurement could lead as well, for example New York State's Office of General Services or New York City's Department of Citywide Administrative Services. Municipalities, affordable housing agencies, and State agencies could use their procurement departments to significantly reduce the cost of solar for buildings, and could even encourage solar installers to innovate on strategic elements such as low-cost canopy designs, simple roof replacement solutions, or attractive financing models, as discussed in earlier sections.

Drawbacks, Limitations, and Barriers

Limitation

Bulk procurement is most straightforward when one housing provider owns multiple buildings that are viable for solar. Scale is paramount to this cost-reduction strategy, making bulk procurement more challenging for an affordable housing provider with a small number of solar viable buildings.

Barrier

Large-scale solar initiatives require large budgets or financing. Often, budgetary constraints cause housing providers to deploy solar in stages, limiting their ability to leverage bulk procurement.

Barrier

Many building owners and organizations do not have the tools or knowledge to run an RFP for solar bulk procurement on their own.

Case Study: Solar One Multifamily Procurement

Solar One provides solar technical assistance for many multifamily building owners in and around New York City. For one client, Solar One prepared and issued an RFP for 11 midrise/high-rise multifamily buildings that were candidates for 50–100 kW DC solar PV installations in 2019. The awarded bid was $2.58/Watt-DC, approximately 20–30% lower than pricing for individual buildings of comparable size and complexity.

6.4.2 Solution: Collaborative Solarize Campaign

Bulk procurement has been a key component of solar campaigns for single-family homes through "solarize" campaigns, where communities organize to install solar together with a single installer and secure better pricing. Often, solarize campaigns are structured with tiered pricing, so that the more homeowners join the campaign, the lower the cost is for everyone participating. This strategy—including lower pricing, a time limit, and community involvement—can be very successful (see this section's case studies). While a solarize campaign is more difficult to organize among multifamily buildings with multiple decision-makers and requires more coordination, it can still yield favorable results if done properly.

For multifamily buildings collaborating on a solarize-type campaign, a few elements must be done properly. The first issue is coordinating the timing: a board of multiple people will take longer to discuss and decide on an investment decision than a single person, and so selecting the right deadline for a campaign that both gives enough time for boards to make decisions and provides enough urgency to be effective is a delicate balance.

Another consideration is communal decision-making. If multiple entities are joining for a single RFP, they need to be able to work closely together and select an installer that all the parties approve. This can be difficult if installer proposals benefit some buildings more than others, so effective moderation and trust between decision-makers is key in order to come to a solution.

Lastly, creating the social pressure of a solarize campaign is more difficult with multifamily buildings than single-family homes, since there are fewer total solar installations in a multifamily campaign. Often boards make the decision to go solar independently of their residents, but in order to generate the interest needed to make a solarize campaign a true community event, all the residents should be bought in, or at least aware of the building's project.

Drawbacks, Limitations, and Barriers

Limitation

It is challenging to coordinate decision-making among multiple housing providers. All parties involved have to be aligned on a timeline, cooperate during the process of leveling bids, and agree to select one installer.

Case Studies/Examples

It is widely understood that bulk procurement has the potential to drive down costs significantly in the solar industry. The Solarize Portland campaign of 2009 through 2011 drove down market prices by 30% and much of that had to do with the scale and coordination of the initiative—1.7 megawatts across 560 homes.[32]

Solar One has observed dramatic savings in its own group purchasing campaigns. In 2016, nonprofits WE ACT for Environmental Justice (WE ACT), Solar One, and the Urban Homesteading Assistance Board (UHAB) collaborated to launch the Solar Uptown Now (S.U.N.) campaign to bring rooftop solar to Housing Development Fund Corporation (HDFC) affordable housing cooperatives in Northern

Manhattan.[33] This campaign, sized at 470 kW-DC across 11 participating buildings, was able to secure standard EPC pricing at $2.70/Watt-DC. This pricing is more than 30% less than the price per watt for a single building (of the same size and type as the average building in the campaign) that purchased solar independently through Solar One's competitive procurement process.

Figure 24. Solar Uptown Now Press Event with WE ACT in Harlem, New York City

Source: Solar One

6.4.3 NYSERDA Recommendations

- Identify potential agencies for bulk procurement and convene them regarding opportunities for solar, such as the New York State Office of General Services: Procurement Division. An agency whose function is bulk procurement is well-situated to develop a solar campaign across its own buildings and bid out the project in bulk.
- For a comprehensive analysis of the benefits of bulk procurement, reference NREL's report, Innovations in Voluntary Renewable Energy Procurement: Methods for Expanding Access and Lowering Cost for Communities, Governments, and Businesses.

7 Policy

7.1 Challenge: Diminishing Tax Incentives

Before the New York City property tax abatement was renewed for 2019/2020 in 2018, Solar One worked with clients who were hesitant to invest in solar projects that had scheduled construction outside the guaranteed years of the property tax abatement. While declining solar incentives can sometimes be a motivating factor for buildings to install solar, in other cases it can have a cooling effect on demand for solar. Solar One has fielded many questions about the stepdown of the Solar Investment Tax Credit, which is due to drop from 30% to 26% in 2020. CEO Buttgenbach of 8minute Solar Energy said that even a modest decline in the ITC to 26% makes a significant difference and can be equivalent to the entire profit margin.[34] While some argue that the solar market has matured to the point where it no longer needs the level of subsidies it once did, others argue that any interventions to incentivize solar will be necessary to meet ambitious climate goals.

On a practical short-term basis, reduced incentives dampen the market for solar PV. However, one upside of the eventual elimination of solar incentives is that it will make it easier to treat solar PV modules like any other building material, because it won't be eligible for a technology-specific incentive. This could accelerate the deployment of solar PV in the context of net zero retrofits and could allow for significant cost compression, counteracting some of the negative effects of declining incentives.

7.2 Proposed Solutions

7.2.1 Solution: Eliminate or Extend Incentive Sunsets and Step Downs

Eliminating the sunset for the NYC property tax abatement would have a positive impact on prospective solar projects over the long term, decreasing uncertainty for those investing in solar and allowing projects to proceed irrespective of a legislative timeline. Extending the Solar Investment Tax Credit at its full value would keep anticipated payback periods at current levels for projects installed in 2020 and have a positive impact on the growth of solar at large.

Drawbacks, Limitations, and Barriers

Drawback and Barrier

Increased monetization of tax incentives comes at a cost to city and state budgets in the form of decreased tax revenue. Therefore, generating the political will to change tax law is incredibly difficult.

Drawback

One positive aspect of predictable sunsets or step-downs is that solar companies and advocates can motivate clients to move forward with projects. Therefore, a potential drawback of extending the incentives for a longer period or indefinitely is the loss of this motivating argument to move forward with solar while the incentives are still available.

7.2.2 NYSERDA Recommendations

- Create platform in the New York State Climate Action Council for maintaining the status quo (at least) of existing incentives in New York State. Draw connections between the need for continuing existing incentives and meeting goals set forth by the Climate Leadership and Community Protection Act (CLCPA).
- Engage NYS legislators to extend the NYC Property Tax Abatement for more than two years. The most recent bill to extend the NYC Property Tax Abatement for solar (S.8049/A.10150) was sponsored by Senator Andrew Lanza and Assembly member Robert Carroll.[35] These legislators are a natural starting point for a discussion around a bill with a longer term or indefinite extension.
- Join the conversation at the national level about the Solar Investment Tax Credit. In July 2019, the Renewable Energy Extension Act was introduced in Congress along with companion legislation in the Senate,[36] which calls for the extension of the Federal ITC. Solar Energy Industries Association, as well as many advocacy groups, has a strong voice in the push for its extension. NYSERDA has the opportunity to lend its voice to this conversation.

7.3 Challenge: Inequities in Access to Tax Incentives

Many potential recipients of the suite of solar tax incentives currently available in New York State cannot claim the full value of those incentives, which in New York City can amount to more than two thirds of the system cost. The federal and State income tax credit, as well as the NYC Property Tax Abatement, are nonrefundable, which means they only have value so long as they are used to reduce taxes owed.[37] This is an issue for nonprofit organizations and affordable housing properties in New York City that do not pay property taxes and therefore cannot take advantage of the solar property tax abatement. It is also an issue for low-income populations who pay little or no income taxes and cannot benefit fully or at all from the federal or State income tax credit. Finally, it is an issue for co-op and condominium buildings that typically have no federal income tax liability but would like the option of having the co-op directly benefit from this tax incentive. For many of the affordable buildings that Solar One works with, tax incentives are excluded from the financial analysis altogether because it is so rare that they can be claimed.

Nonrefundable tax credits are regressive, delivering the least benefit to non-profits and low-income residents. Solar tax incentives are not valuable to building owners that can't claim tax incentives, including multifamily owner-occupied homes with a large number of residents that can't claim tax incentives. For co-ops and condos, a related issue is that solar projects paid for with shared resources may not deliver equitable benefit to all of the residents, because some are unable to claim the tax incentives.

The NY-Sun incentive program in its current iteration includes multiple adders in addition to the base rebate. One of these adders is the affordable adder, but there are limits to its application, and therefore does not support solar on affordable housing to the extent that it could.

7.4 Proposed Solutions

7.4.1 Solution: Refundable Tax Incentives

Refundable tax credits is a comprehensive way to improve equitable access to solar incentives among low-income individuals and affordable housing providers. If this were implemented, the individuals and organizations who are most in need of the incentives would be able to claim their full value irrespective of their income and tax status. This reform could apply to the federal and State income tax credits, and the New York City property tax abatement.

Refundable tax credits also provide a more straightforward path for any multifamily building in claiming the federal income tax credit. Since most co-ops and condominiums do not have federal income tax liability, they cannot claim the federal income tax credit as a commercial incentive (hence the common practice of distributing the residential tax credit pro rata among shareholders/owners instead). There are many cases where the co-op would prefer to directly claim the tax credits, thereby simplifying the process of recouping the value of a solar project.

Drawbacks, Limitations, and Barriers

Drawback and Barrier

Increased monetization of tax incentives comes at a cost to city, State and federal budget in the form of decreased tax revenue. Therefore, generating the political will to change tax law is incredibly difficult, especially at the federal level where the majority of decision-makers are likely less accessible than those at the State.

Case Study: New York Historic Homeowner Rehabilitation Tax Credit

Refundable tax credits already exist at many levels of government. One tax credit that is structured this way is the Historic Tax Credit in New York State.[38] This tax credit allows for buildings installing solar (and making other capital improvements) within a Historic District or a Landmark Building *and* in an income-qualifying census tract to receive a New York State income tax credit. In the case of a co-op or condo, if an individual owner has an income of less than $60,000 per year, any credit they cannot claim during the first year of the system's operation is 100% refundable. This program has improved the economics of multiple projects that Solar One has facilitated in low-income areas.

7.4.2 Solution: Expand and Improve the NY-Sun Affordable Adder

In 2018, NYSERDA launched New York State's first multifamily affordable housing solar incentive. The incentive provides an added $0.40/Watt-DC for the first fifty kilowatts-DC of each solar project on an eligible property. This incentive helped catalyze dozens of multifamily affordable solar projects in New York City during its first year of availability, demonstrating the significant demand. NYSERDA has since expanded the NY-Sun Affordable Adder, at $0.30/Watt-DC, to the rest of the State. While the Affordable Adder has achieved the desired outcome of inducing additional solar projects on affordable housing, the program could be further optimized.

Solutions

- Eliminate 50 kW-DC cap
- Consider emulating the California Solar on Multifamily Affordable Housing (SOMAH) incentive program design, which provides greater incentive for systems that deliver more benefit to tenants and for nonprofit owners

Drawbacks, Limitations, and Barriers

Limitations

There is a limited pool of funding from which NYSERDA can draw funds for the incentive. NYSERDA has been allocated a fixed amount of money for the NY-Sun program at large, and any expansion or elimination of caps will draw it down more quickly. However, affordable housing is disadvantaged relative to many other sectors that are pursuing solar and warrants increased investment by the State.

7.4.3 NYSERDA Recommendations

- Conduct a study to more accurately forecast the impact of refundable tax credits (federal, State, or city) on growth of solar in New York State to provide a foundation for generating political will.
- Engage New York State legislators who chair relevant committees to understand the political appeal for modifying existing law to make tax credits refundable (for New York State Income Tax and NYC Property Tax Abatement), using the new Climate Leadership and Community Protection Act as leverage.
    - In recent years, the New York State Senate and Assembly have introduced bills to increase the New York State tax credit for solar energy system equipment,[39] and these legislators might be natural allies. Key players include Senator Velmanette Montgomery and Assembly member Latrice Walker.
- Secure additional funding for NY-Sun incentive with the implementation of the Climate Leadership and Community Protection Act. In order to accomplish the goals, set forth in the CLCPA, NYSERDA must be equipped with a larger budget to support the development of renewable energy in the State. This funding can be used to modify existing incentive structures and to expand and increase the affordable adder.

7.5 Challenge: Missed Opportunities for Supporting Growth of Solar Industry

Solar One often engages with building developers who are interested in solar for new construction but are non-committal for a range of reasons. These reasons include: unknowns about the future site's electricity consumption, lack of clarity about how to recoup investment (in rental buildings where tenants will pay their own bills), and an attitude that it can happen at any point down the line if the owner so chooses. Solar One also engages with owners of existing buildings who are weighing the relative necessity of various capital improvements, and often put solar as a low priority relative to crucial building upgrades. Both scenarios represent missed opportunities for solar and can be mitigated by policy.

7.6 Proposed Solutions

7.6.1 Solution: Expand Solar Mandate for New Construction

In April of 2019, New York City passed a package of bills known at the Climate Mobilization Act. One of these bills is a solar and green roof mandate for most new construction as well as certain types of building renovations.[40] While New York City's bill is structured so that there is a five-year delay before the new requirements are applicable to affordable housing, the affordable housing sector will be impacted in time.

Including solar in the design and construction of buildings enables optimized design and cost reduction. Furthermore, timing the installation of solar with a new roof is ideal because it decreases the likelihood that solar panels will need to be removed and replaced for roof rehabilitation during the lifetime of the solar PV system.

Expanding New York City's solar mandate to the rest of New York State would have a comparable positive impact on the growth of solar statewide.

Drawbacks, Limitations, and Barriers

This solution is dependent on generating the political will to support and prioritize this policy change and will likely experience opposition from the building industry.

Case Studies/Examples

The Climate Mobilization Act is too new to measure its impact. The State of California introduced similar legislation in 2018, requiring the installation of solar panels on any new single-family or multifamily homes that are three stories or less.[41] However, this mandate does not take place until 2020, so the impact is difficult to measure in California as well. In 2020, it is estimated that 80,000 new homes in California will install solar.[42]

7.6.2 Solution: Include Roof Rehabilitation in Basis for Income Tax Credits

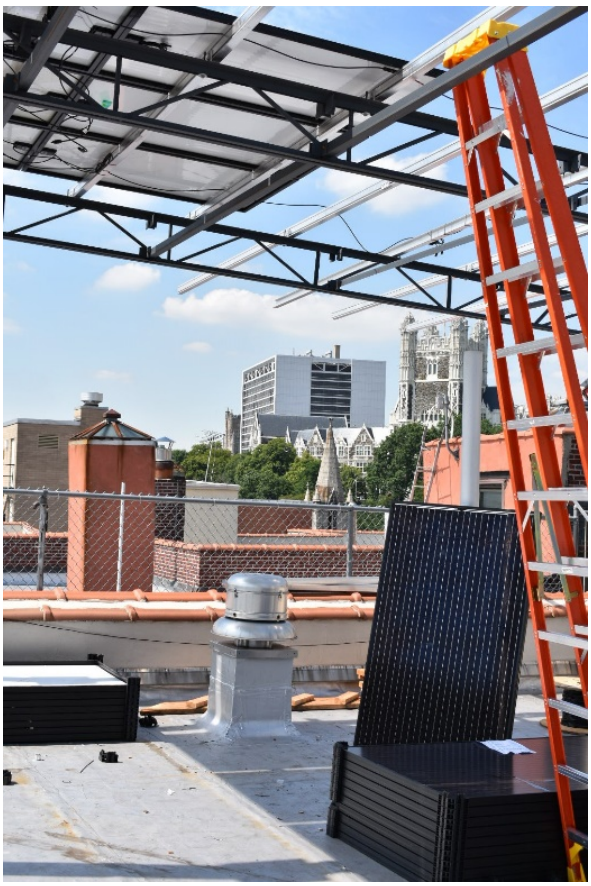
If the cost of roof rehabilitation were included in the basis for the federal and State income tax credits, roof rehabilitation and solar installation would more frequently happen in conjunction and helping overcome roof age/condition as a barrier to solar adoption. A broader inclusion of roof rehabilitation costs in the basis for solar tax incentive would also likely drive a transition toward business model integration.

Drawbacks, Limitations, and Barriers

Generating the political will to support and prioritize this policy change. The increased monetization of tax incentives will increase the cost to the city and State in decreased tax revenue.

Figure 25. Rooftop Solar Canopy Installation in Progress, Harlem, New York City

Source:Solar One



7.6.3 NYSERDA Recommendations

- Promote the expansion of the mandate for solar on new construction across New York State. NYSERDA could use the New York City bill as a model and promote solar mandates through programs focused on engaging with municipalities such as the Clean Energy Communities Program. Solar mandates for new construction could also be integrated into the New York State building code, which would accelerate adoption of such a mandate by municipalities statewide. With the rules being determined for the Climate Leadership and Community Protection Act at the State level, it is possible that there is an opening for a solar mandate for new construction as a strategy for reaching New York State's renewable energy goals.
- As recommended for the reforms to the income tax credits, NYSERDA could engage legislators who have already introduced bills on this subject to explore a more comprehensive reform to the structure of the incentives.

8 Manufactured Homes: A Window of Opportunity

Companies producing manufactured and modular homes in and around New York State could be valuable partners for NYSERDA's efforts to accelerate the development and deployment of net zero energy homes. Twenty-two million Americans live in manufactured homes, including thousands of New Yorkers, and in 2017, approximately 92,891 new manufactured homes shipped in the United States including 1,429 to destinations in New York.[43] The companies that manufacture these prefabricated homes are already utilizing an efficient assembly line approach to constructing homes. Historically, manufactured homes have not been designed with rooftop solar PV retrofits in mind. However, their factories, expertise, and supply chain make these companies natural partners to organizations such as NYSERDA that are seeking to scale up the development of assembly line solutions for deep energy retrofits and net zero homebuilding. NYSERDA could potentially learn from the home manufacturers and seek their consultation on how to support net zero home building and retrofit solutions.

With support from NYSERDA and other governmental and financial institutions, home manufacturers could develop new net zero home models that rely on the technologies and strategies of Energiesprong. For example, pre-fabricated homes certified to meet net zero standards could be pre-approved for financing for the incremental cost of the net zero elements of the project based on forecast utility bill savings, or net zero homes could be eligible for targeted incentives to encourage their sale. HUD and the State of New York regulate modular home manufacturers to ensure quality, and the New York Department of State maintains a list of companies registered to build and distribute manufactured homes in the State.[44] These companies are all potential partners for product development and thought partners for incentive and program design to accelerate the development and deployment of net zero homes. These companies may also have the facilities, supply chain, distributor network and technical know-how to develop deep energy retrofit products and services. For the right company, developing a deep energy retrofit product line could dramatically increase their profitability by providing them access to a larger addressable market.

One strategy to maximize impact could be to seek strategic partnerships with modular/manufactured home manufacturers with regional and national footprint as well as a New York State presence. Clayton Homes is America's largest manufactured home builder, with 47% of the total market share.[45] However, it does not have any New York facilities. Skyline Champion (aka Titan Homes) is the second largest

manufactured home builder in the United States, with 17% market share, and it has a factory located in Sangerfield, NY. This company, with a New York State-based factory and a national footprint, could be a powerful launching pad for NYSERDA to pilot and scale RetrofitNY solutions for net zero new construction and deep energy retrofits.

In addition to these large national home manufacturers, there are also innovative small businesses emerging in the State committed to building next generation net zero manufactured homes. While the scale of these operations is less significant, their focus on net zero building and integrating solar could make them ideal partners for scaling up novel solutions to achieve net zero new construction and retrofits.

8.1 Case Study: The Solar Home Factory

The Solar Home Factory is a small business based in Geneva, NY that was founded by Ryan Wallace in 2016 with the goal of creating net zero manufactured homes and net zero home communities using modular construction, tight building envelopes, efficient appliances, and rooftop solar. The company's factory began operations in 2018, and they have already completed construction for multiple "solar villages" in Geneva and Ithaca, NY. According to a recent interview with the founder and CEO,[46] in five years they hope to have one hundred employees and to be building 50–60 homes and 200–300 apartments annually.

Figure 26. Rendering for a Solar Powered Modular Home

Source: The Solar Home Factory

8.2 Manufactured Housing Resources

Organization	Website	Description
Manufactured Housing Institute	https://www.manufactured housing.org	The Manufactured Housing Institute (MHI) is the only national trade organization representing all segments of the factory-built housing industry. MHI members include home builders, retailers, community operators, lenders, suppliers, and affiliated state organizations.
New York Department of State	https://www.dos.ny.gov/DCEA/ manuf.htm	NYS Division of Building Standards and Codes regulates mobile and modular homes to ensure compliance with all federal and local requirements for quality and safety.
New York Housing Association	https://nyhousing.org/	The New York Housing Association, incorporated in 1950, is a trade group formed to address concerns of factory-manufactured home builders, retailers, and community owners in New York State.
Modular Building Institute	http://www.modular.org/	The Modular Building Institute is an international trade organization whose membership includes companies involved in the manufacture, distribution, and assembly of modular buildings.
United States Department of Energy	https://www.nrel.gov/docs/fy13osti/56761.pdf	Northwest Energy Efficient Manufactured Housing Program Specification Development, a 2013 publication by the U.S. Department of Energy Building Technologies program defining energy efficiency strategies for manufactured homes.
Energy Star (joint initiative of the US Department of Energy and the EPA)	https://www.energystar.gov/ partner_resources/residential_ new/working/builders_developers /guidelines_plants/designing_ manufactured_homes	Energy Star certification guidelines for manufactured homes developed by the U.S. Department of Energy and the Environmental Protection Agency.

9 Conclusions

While the upfront cost of solar PV remains the single biggest barrier to its deployment on affordable housing, there are many strategies that NYSERDA can pursue to accelerate the adoption of cost-effective solar in this segment of the market. NYSERDA is, in fact, already pursuing many of these strategies, and the recommendations in this report may help inform future directions for its programmatic interventions to support solar on affordable housing. NYSERDA can execute some of these strategies directly through its existing programs, such as NY-Sun, RetrofitNY and the Clean Energy Communities Program, while most other recommended strategies will require close collaboration with diverse stakeholders, including solar installation companies, equipment manufacturers, financial institutions, AHJs around the State, and companies in adjacent industries such as modular building and manufactured homes. Still other strategies are better addressed at the federal level by organizations such as the National Renewable Energy Laboratory and HUD. Given NYSERDA's unique role in New York State's solar and energy efficiency industries, NYSERDA is ideally positioned to either drive these efforts directly or to shepherd them forward as a convener of various stakeholders in the public and private sector, or even as a stakeholder participating in national initiatives in collaboration with NREL and other state-level clean energy agencies.

For NYSERDA's RetrofitNY program, which focuses on particular types of strategies for cost-reduction, the strongest recommendation from this report is for staff to engage with the modular building and manufactured home industry regarding net zero construction and retrofits. The manufactured home industry has already adopted many of the cost-reduction strategies that are central to Energiesprong, such as automated indoor assembly-line construction for rapid field assembly. The companies operating modular home factories in and around New York State could be strong partners for developing and scaling up rapid deep energy retrofit solutions. There is no single strategy that will bring cost-effective solar PV to affordable housing across the State, however the collective impact of the recommendations in this report will deliver significant progress toward RetrofitNY's goal of net zero affordable housing powered by solar PV in both the urban and rural context.

Endnotes

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