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Solar+Storage for Low- and Moderate-Income Communities

A Guide for States and Municipalities

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SUSTAINABLE SOLAR EDUCATION PROJECT

Marcus Garvey Village solar array, courtesy of L+M Development Partners Inc.

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U.S. Department of Energy

Clean Energy States Alliance

ABOUT THIS GUIDE AND THE SUSTAINABLE SOLAR EDUCATION PROJECT

Solar+Storage for Low- and Moderate-Income Communities: A Guide for States and Municipalities is one of six program guides being produced by the Clean Energy States Alliance (CESA) as part of its Sustainable Solar Education Project. The project aims to provide information and educational resources to help states and municipalities ensure that distributed solar electricity remains consumer friendly and its benefits are accessible to low- and moderate-income households. In addition to publishing guides, the Sustainable Solar Education Project will produce webinars, an online course, a monthly newsletter, and in-person training on topics related to strengthening solar accessibility and affordability, improving consumer information, and implementing consumer protection measures regarding solar photovoltaic (PV) systems. More information about the project, including a link to sign up to receive notices about the project's activities, can be found at *www.cesa.org/projects/sustainable-solar*.

ABOUT THE U.S. DEPARTMENT OF ENERGY SUNSHOT INITIATIVE

The U.S. Department of Energy SunShot Initiative is a collaborative national effort that aggressively drives innovation to make solar energy fully cost-competitive with traditional energy sources before the end of the decade. Through SunShot, the Energy Department supports efforts by private companies, universities, and national laboratories to drive down the cost of solar electricity to $0.06 per kilowatt-hour. Learn more at *www.energy.gov/sunshot*.

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DISCLAIMER

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SECTION 1

Introduction

This guide seeks to provide state and municipal officials with information to develop effective solar and battery storage (solar+storage) policies and programs that benefit low- and moderate-income (LMI) communities.

Typically, new technologies are acquired first by those who can afford to pay a premium for them, such as wealthy early adopters and big, tech-savvy corporations. Eventually, the benefits that new technologies can offer will become available to lower-income communities. But in order for that to happen, production costs have to come down, markets have to mature, and industries supporting the technologies, such as the financing and insurance industries,

The McKnight Lane affordable housing development has net-zero Vermod modular homes installed with solar+storage systems in Waltham, VT.

have to offer established support products. This can take quite a while, as can been seen in the case of solar photovoltaics (PV), which, after many years as a niche technology, has become a mainstream technology in many parts of the country. However, for a variety of reasons, LMI communities are still not participating proportionately in the solar market.

It is important that solar+storage technologies become accessible to LMI communities sooner rather than later, because these communities are most in need of the many benefits solar+storage can provide. These benefits include, in many cases, greater cost savings than can be provided by solar alone, along with reduced risk of future devaluation of solar PV. Resilient power, defined here as the ability to self-supply with electricity when the grid is down, such as during a natural disaster, is another key benefit.

This guide explores a range of policy approaches that have been successfully employed and provides program examples from states that have made LMI access to these technologies a priority.

Studies have shown that LMI customers, on average, pay an inordinate portion of their income for energy and may not be in a position to easily take advantage of technologies, such as energy efficiency upgrades, that could provide relief from energy costs.[1] While the use of solar PV in LMI communities can provide energy cost savings, the additional use of energy storage (batteries) coupled with solar PV can often provide greater savings than solar alone, and in some cases result in a shorter payback period. This is because energy storage can be used to reduce demand charges, which can be a significant portion of the electric bill for commercial customers (including, in most states, multifamily affordable housing facilities). Because solar PV alone is not dispatchable (able to be turned on or off at need), it cannot, by itself, reliably provide demand charge reductions and associated cost savings.

There are also studies showing that LMI households are the most vulnerable to—and often the hardest hit by—natural disasters, including hurricanes, tornadoes, ice storms, and flooding, which can disrupt the electric grid for days or even weeks.[2] And unlike wealthier customers, who can temporarily relocate until grid power is restored, LMI customers may not have the resources and ability to do so. Solar+storage can provide long-duration backup power for these customers, allowing them to shelter in place when the grid goes down.

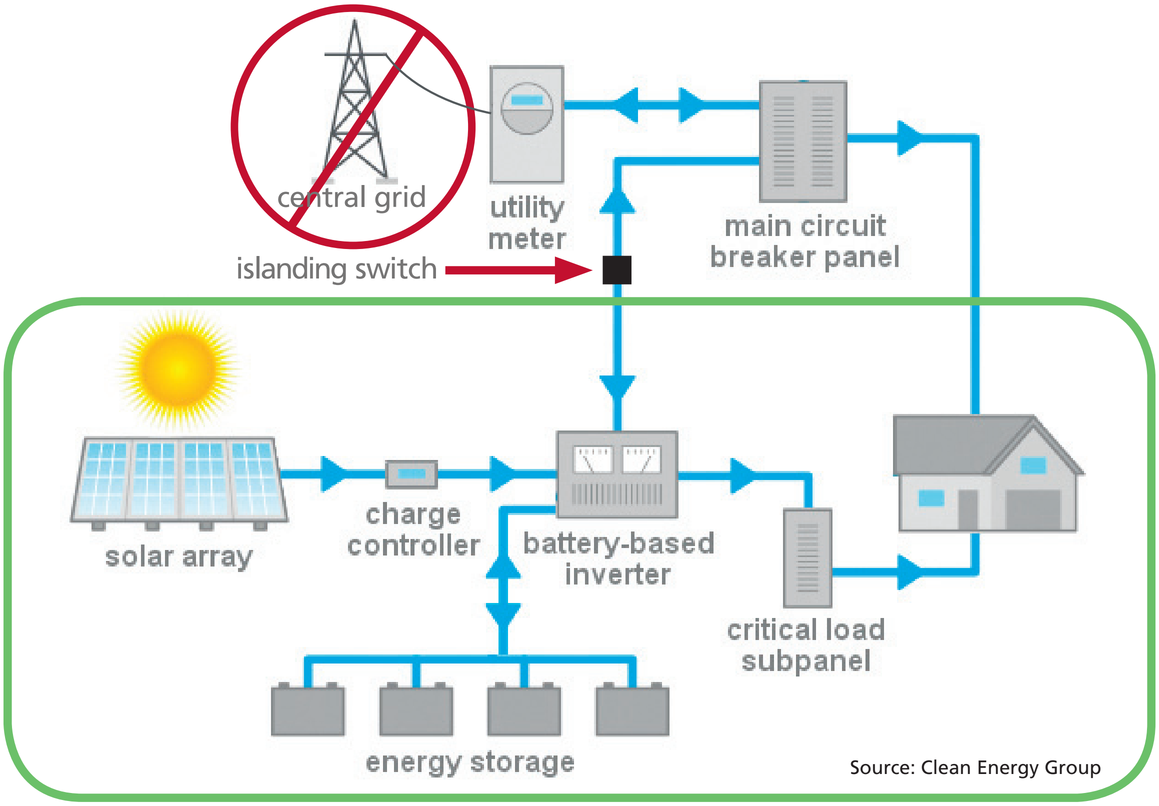
As they have with other clean energy technologies, states and municipalities can use readily available policy tools to support the deployment of solar+storage to benefit LMI communities—not decades in the future, but now. This guide explores a range of policy approaches that have been successfully employed and provides program examples from states that have made LMI access to these technologies a priority.

SECTION 2

What Is Solar+Storage?

Solar+storage is a marriage of two clean energy technologies, solar PV and battery storage. It is capable of providing unique benefits that cannot be achieved by the use of either solar or storage alone. These benefits, and associated value streams, depend somewhat on where solar+storage systems are placed. For example, small, behind the meter (BTM) systems can provide resilient power and energy cost savings to their host facility, while larger systems located on the utility grid can provide resilience to one or

FIGURE 1: **Islanded Resilient Power System**



Solar+storage systems incorporate two clean energy technologies: solar photovoltaic panels (PV) and energy storage, usually in the form of a battery. Typically, solar+storage systems also include additional hardware such as an inverter for converting the PV panels' output from DC to AC, and often require software and system controls. They will also require islanding switches if the system is designed to operate when the electric grid goes down.

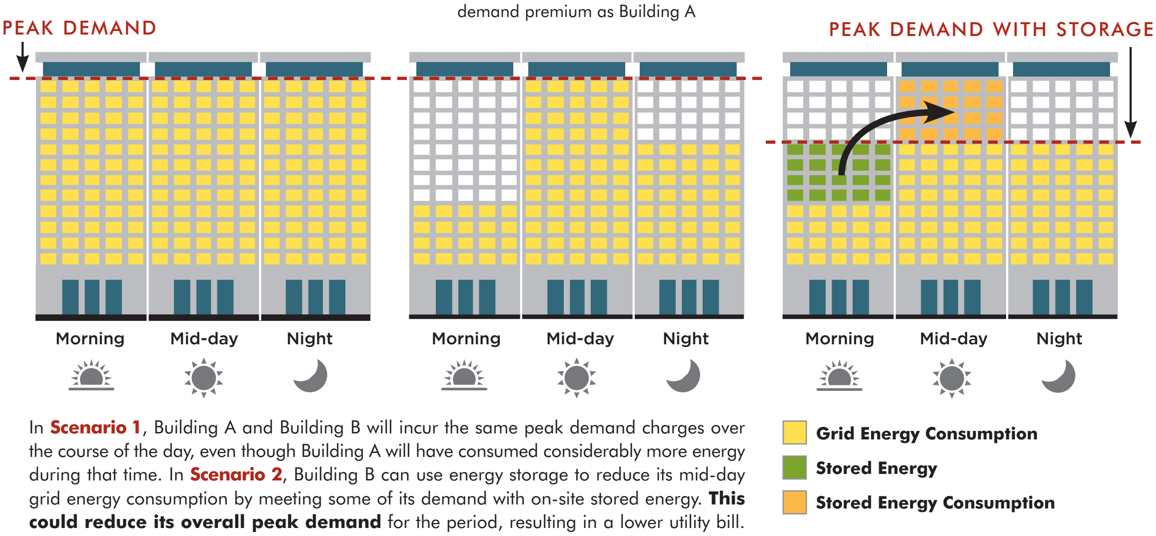
FIGURE 2: How Energy Storage Can Reduce Demand Charges

Demand is the total amount of electric load required by the customer's electric equipment operating at any given time. Utilities assess demand charges based on the highest average demand, (i.e. Peak Demand) that occurs over any interval (usually 15-minutes) during each billing period, and it is measured in kilowatts. Utilities assess energy consumption charges based on the total amount of electricity consumed over any period, and it is measured in kilowatt-hours.

Building A
Has high energy consumption and reaches the same high level of demand throughout the day and night

Building B (Scenario 1)
Only reaches its highest level of demand in the middle of the day, consuming less energy, but paying the same peak demand premium as Building A

Building B (Scenario 2)
Stores energy in the morning to offset high demand in the middle of the day, lowering utility peak demand



In **Scenario 1**, Building A and Building B will incur the same peak demand charges over the course of the day, even though Building A will have consumed considerably more energy during that time. In **Scenario 2**, Building B can use energy storage to reduce its mid-day grid energy consumption by meeting some of its demand with on-site stored energy. **This could reduce its overall peak demand** for the period, resulting in a lower utility bill.

more public community resources (e.g., public shelters, fire and police stations, and water treatment plants) while offering energy cost savings to ratepayers.[3]

The benefits of combining solar with battery storage are easy to understand if we consider the shortcomings of each technology alone. Storage is not in itself a renewable resource, because it does not generate energy. Solar PV is a renewable generator, but not one that can be dispatched on demand, since PV panels only generate electricity when the sun is shining. Combining the two technologies yields a renewable resource that *is dispatchable*, thus overcoming the main criticism of renewables—that they are intermittent generators incapable of producing energy on demand. With the addition of a simple islanding switch that can be used to physically separate a BTM solar+storage system from the grid, a solar+storage system becomes a small microgrid, which can interact with the larger grid during normal operations as well as provide power for critical loads behind the meter when the larger grid goes down (see Figure 1), or during high demand hours when grid power is more expensive (in cases where demand charges or time-of-use rates apply, see Figure 2).

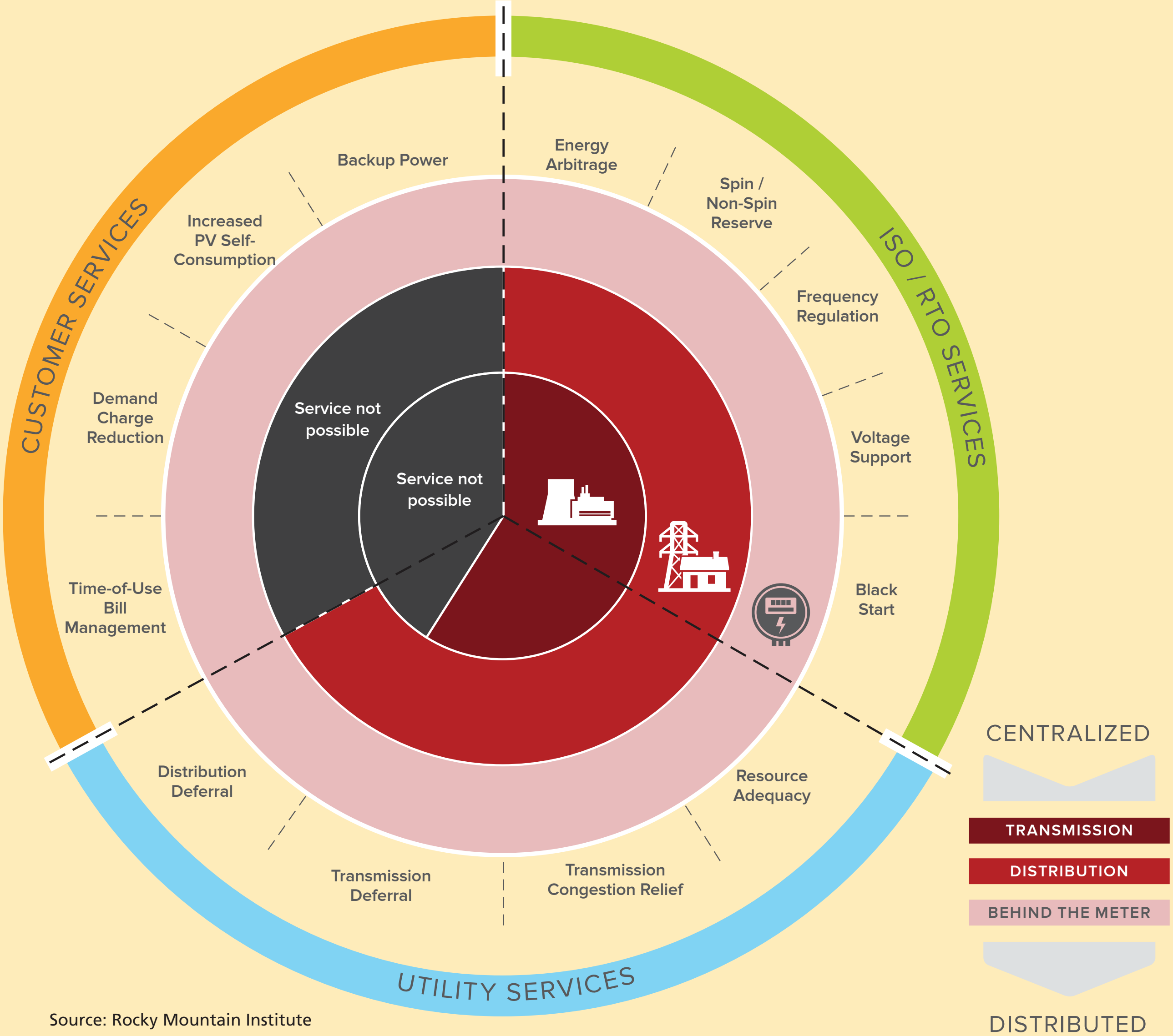
Because adding storage to solar allows the renewably generated electricity to be time-shifted, solar+storage systems can access value streams such as demand charge management, arbitrage, demand response, and other electricity market revenues that solar alone cannot take advantage of. And adding storage to solar PV can provide a hedge against the erosion of solar values; if net metering rates decline, customers with solar+storage systems can self-consume excess solar generation, displacing purchases of grid power at retail rates.

BOX 1

The Economics of Battery Storage

As shown in this graphic from the Rocky Mountain Institute report, "The Economics of Battery Storage,"[4] BTM systems can theoretically provide a wider range of benefits than utility distribution grid-based systems, because they can directly benefit their host site, while also providing grid benefits. However, utility-scale or large third-party systems (sited on the distribution or transmission grids) can offer economies of scale and may have more direct access to markets and revenue streams not readily available to BTM systems. In both cases, good public policy can ensure that LMI communities benefit from these systems.

FIGURE 3: **Batteries Can Provide up to 13 Services to Three Stakeholder Groups**



Source: Rocky Mountain Institute

SECTION 3

Why Solar+Storage for LMI Communities?

While still rare, there are a few examples of solar+storage projects for LMI communities. These include the McKnight Lane redevelopment project, in Vermont; Marcus Garvey Apartments, in New York; and 2500 R Midtown, in California. As these example projects show, benefits of solar+storage for LMI communities generally fall into two categories: energy cost savings and energy resiliency.

COST SAVINGS

For decades, state energy agencies have recognized the importance of providing energy efficiency resources to LMI communities. More recently, solar PV was added to some LMI clean energy programs. Energy storage, together with solar and efficiency measures, completes a three-legged stool that can reduce or even essentially eliminate electricity costs.

A significant advantage of adding energy storage to a BTM solar system is that it allows the building owner to manage demand charges, something solar and efficiency measures alone cannot do. Demand charges are not generally applied as a separate charge on residential electric bills, but they are making up an increasingly large portion of commercial electric bills—up to more than half the total bill in some areas. (See Figure 4.) Demand charges are calculated by the utility, based on the building's peak electric demand each month; so by reducing that monthly peak, the demand charge can be significantly reduced. (See Figure 5.) Because many LMI families rent apartments in multifamily affordable housing facilities that have common area loads—such as lighting, elevators, and laundry rooms—that are assessed by utilities as commercial loads, the cost of electricity for multifamily housing can be significantly reduced through demand charge management using solar+storage technologies. In order for such an approach to directly benefit tenants, some mechanism for sharing benefits between building owner and tenants must be in place, such as is required by the California Multifamily Affordable Housing Solar Roofs Program, established by California AB 693.[5]

Solar+storage is well suited to reduce demand charges because batteries can be charged by solar at midday, and discharged during demand peaks.

Solar+storage is well suited to reduce demand charges because batteries can be charged by solar at midday, and discharged during demand peaks. Similarly, in areas where customers

FIGURE 4: **Explanation of Charges Commonly Found on an Electric Bill**

Charges on an Electric Bill

Electric bills are primarily composed of three types of charges: energy charges, demand charges, and fixed charges.

Energy charges:
Energy charges (measured in kilowatt-hours) are based on the amount of electricity consumed from the grid over each billing cycle. Energy charges can vary depending on season and the time of day electricity is consumed (time-of-use rates) or the amount of electricity consumed (tiered rates).

49%

Sample Annual Electric Bill

ENERGY

		Usage (kWh)	Cost ($/kWh)	Total cost ($)
Max	Summer	13,085	0.11447	1,497.82
	Winter	7,827	0.10565	826.97
Peak	Summer	15,259	0.10568	1,612.59
	Winter	35,189	0.09132	3,213.46
Part-Peak	Summer	26,959	0.07920	2,135.17
	Winter	46,612	0.07160	3,337.42
TOTAL		**144,932**		**$12,623.43**

DEMAND

		Avg peak (kW)	Cost ($/kW)	Total cost ($)
Max	Summer	33	22.55	2,958.56
	Winter	30	22.55	5,195.52
Peak	Summer	33	19.19	2,517.73
	Winter	24	6.86	1,279.49
Part-Peak	Summer	30	0.00	0.00
	Winter	30	0.00	0.00
TOTAL				**$11,951.30**

FIXED

	Total cost ($)
Meter charge	1,397.28
TOTAL	**$1,397.28**

TOTAL ANNUAL BILL $25,972.01

Demand charges:
Demand charges (measured in kilowatts) are based on the highest rate of electricity consumption during a billing cycle, called peak demand. Utilities assess peak demand by measuring the highest average demand that occurs over any 15-minute period each billing cycle. Demand charges can vary depending on season and the time of day when peak demand occurs. Demand charges are typically found only on commercial or industrial customer accounts, where they often represent about half of the cost of an electric bill. Residential customers are usually not assessed these charges.

46%

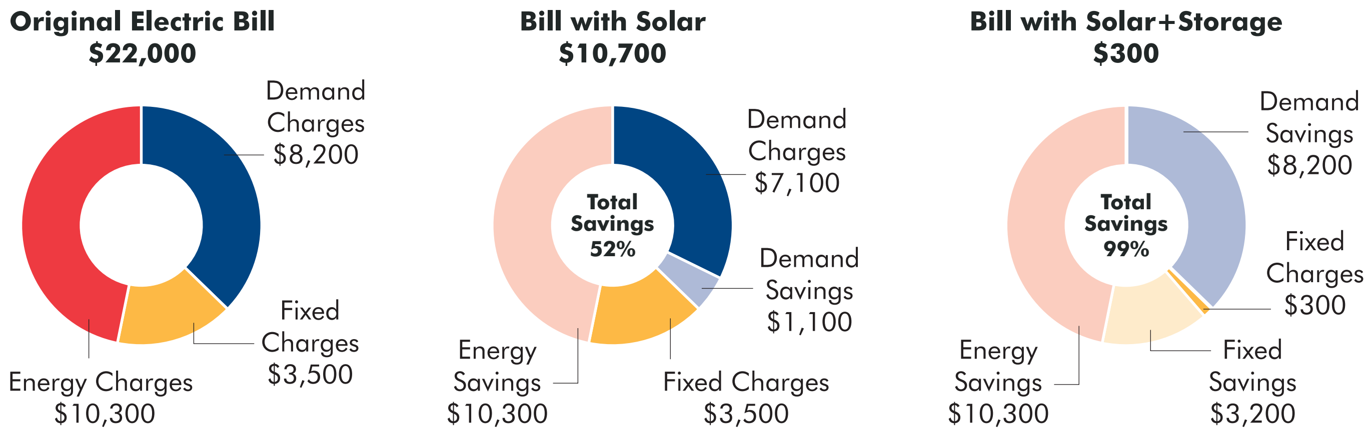
5%

Fixed charges:
Fixed charges are usually static and do not vary from one billing cycle to the next. These charges typically cover the costs of metering, billing, and other customer-related operating expenses not accounted for in energy and demand charges. Fixed charges can also include additional fees to cover system benefit programs such as energy efficiency and renewable energy programs. For simplicity, only fixed charges related to billing and metering are considered in this analysis.

A sample electric bill from a multifamily residential building in San Diego, from a Clean Energy Group report, *Closing the California Clean Energy Divide.*[6]

pay more for electricity during high demand times under time-of-use (TOU) rates, storage can be used for energy time-shifting (sometimes called "arbitrage") to protect customers from paying the highest prices for grid power, by instead using stored power from the batteries during these times. Solar alone cannot be relied upon to reduce demand charges or protect against high TOU rates, because it only generates electricity when the sun is shining with no control over when it is used. Without storage, even one cloudy day in a billing period could erase all the potential demand charge savings for a customer. Furthermore, the electricity generated by many net-metered solar systems is not deducted from the host facility's demand, even if the solar generation is coincident with the demand peak. This is because while net-metered, solar-generated electricity is sold to the utility, the facility is still purchasing grid power. The net-metered power offsets total monthly electricity purchases, but does nothing to shave peak demand.

FIGURE 5: **Impacts from the Addition of Solar and Solar+Storage on Electricity Bills**



Sample building original electric bill, electric bill and savings after deployment of solar, and electric bill and savings after deployment of solar+storage. Solar eliminates energy consumption expenses and lowers demand charges, saving $11,400. The addition of battery storage eliminates demand charge expenses and lowers fixed charges, saving an additional $10,300 per year.[7] (Data from Southern California Edison's service territory.)

In some cases, adding energy storage to BTM solar systems can reduce the overall system payback period as compared with solar alone. In other cases, it may not have a positive effect. This is shown in the three-city comparison performed by Clean Energy Group. (See Figure 6.) Whether the addition of storage improves overall project economics or not depends on many factors. State and municipal incentives, the applicability of federal tax benefits, the price of electricity, the structure of utility rates, and utility and grid market opportunities can all influence the economics of solar+storage systems.

A second financial benefit of adding battery storage to BTM solar systems is that batteries can provide a hedge against the devaluation of solar PV. Increasingly, utilities have proposed

TABLE 1: **Project Comparison Summaries by City**

Chicago Project Summary			
System Size	200-kW solar-only	200-kW solar +100-kW/ 50-kWh lithium-ion battery	200-kW solar + 300-kW/ 150-kWh lithium-ion battery
Initial Cost*	$493,000	$606,000	$832,000
Payback Period	20+ years	11.8 years	6.2 years

* Initial project costs refer to year zero net project expenses after federal tax credits and any additional tax credits have been applied.

Washington, D.C. Project Summary		
System Size	360-kW solar-only	360-kW solar +100-kW/ 50-kWh lithium-ion battery
Initial Cost	$788,000	$901,000
Payback Period	3.5 years	3.5 years

New York City Project Summary		
System Size	30-kW solar-only	30-kW solar + 30-kW/ 60-kWh lead-acid battery
Initial Cost	$58,000	$128,000
Payback Period	4.3 years	14.2 years

Source: Clean Energy Group

This three-city comparison shows that in some cases, adding storage to BTM solar at multifamily affordable housing facilities can improve the economics of the overall project. For more information, see Clean Energy Group's report, *Resilience for Free: How Solar+Storage Could Protect Multifamily Affordable Housing from Power Outages at Little or No Net Cost*.

reduced net energy metering (NEM) compensation rate—even, as in the case of Nevada, retroactively (the Nevada Public Utility Commission increased fees and reduced net metering rates for existing net-metered customers in 2015. The decision was reversed in 2016). In 2015, Greentech Media reported that more than half of all U.S. states were studying or changing their NEM policies.[8] Other changes in rate structures can also effect the value of solar—for example, shifting higher TOU rates later in the day, as is happening in California. The potential for reduced NEM rates and shifted TOU rates means that solar customers can be exposed to regulatory risk; in effect, the value of their PV systems can go down as the benefits from solar net metering are reduced. For low-income communities, this is an unacceptable risk. But the addition of batteries to BTM solar systems can help guard against some of these risks by allowing customers to store and later self-consume excess electricity generated by their solar panels, offsetting electricity they would otherwise purchase at retail rates.

Adding batteries behind the meter can also provide cost savings to the utility serving the facility, if the system is configured to allow the utility to draw from the batteries during peak demand hours. Known as a "virtual power plant," this arrangement allows utilities to aggregate many BTM battery storage systems and use them as a resource to cut capacity and transmission cost obligations by reducing the utility's demand during annual and monthly regional demand peaks. Utilities and regional grid operators can also use aggregated storage systems to provide valuable grid services, such as frequency regulation and flexible ramping.

The cost savings from this sort of arrangement can partially offset the cost of the batteries.[9]

BOX 2

The "Split Incentive" Problem

Clean energy incentive policies and programs targeted toward LMI communities commonly run into the "split incentive" problem—renters who pay their own electric utility bills are motivated to reduce their energy costs, but because they do not own the property, they have little ability to install clean energy technologies to do so; while landlords, who own the property and may have the ability to install clean energy technologies and upgrades, have little motivation to do so if they are not responsible for paying tenant electric bills. In this situation, government incentives sometimes have little impact, as property owners are generally reluctant to make investments in their properties unless they will directly benefit financially (and in fact, they may have difficulty financing such investments).

There are instances where property owners can directly benefit from installing solar+storage systems, for example, when energy costs are included in tenant rents, or when there are significant energy costs associated with common areas in large multifamily buildings, for which landlords are responsible. However, in these cases, tenants may not receive a share of the benefits when landlords take advantage of incentives to install cost-saving technologies—i.e., energy costs for the property owner may decrease, but this may not be reflected in lower rental rates.

California's Multifamily Affordable Housing Solar Roofs Program attempts to address the split incentive problem. The program requires that cost savings from rooftop solar on affordable, multifamily housing facilities be shared between the building owner and tenants.[10] This approach could easily be used with solar+storage systems.

For more information on how the addition of storage to rooftop solar in affordable, multifamily housing properties can improve system economics and shorten paybacks, see the Clean Energy Group report, *Closing the California Clean Energy Divide: Reducing Electric Bills in Affordable Multifamily Rental Housing with Solar+Storage*.

RESILIENCY

Energy resiliency is important for LMI communities because, historically, these communities have been hit harder by disasters and associated grid outages than the general population. And these communities typically have fewer resources available to help them recover after a disaster. Evacuation is often problematic, since low-income people tend to have fewer places to go and may not be able to afford travel and temporary accommodations. Numerous studies have documented the disproportionate harm done to LMI communities by these extreme weather events. For more information, see:

- A Long Road Home—An article published in *The Atlantic* by Gillian B. White (Aug. 2015)
- Climate Change: The Poor Will Suffer Most—An article published in *The Guardian* by Suzanne Goldenberg (Mar. 2014)
- Extreme Weather Hits Poorest Hardest—An article published in *Scientific American* by Benjamin Hulac (July 2014)
- One Storm Shy of Despair: A Climate-Smart Plan for the Administration to Help Low-Income Communities—A Center for American Progress report by Cathleen Kelly and Tracey Ross (July 2014)
- Resilient Power: Evolution of a New Clean Energy Strategy to Meet Severe Weather Threats—A Clean Energy Group report (Sept. 2014)

With the addition of BTM solar+storage systems to support housing and other critical facilities in LMI communities, first responders could continue to serve residents during grid-disrupting disasters, and families could shelter in place, avoiding costly and dangerous evacuations. Solar+storage systems can be designed not only for large, multifamily affordable housing facilities in urban centers, but also for rural affordable housing, as shown by the McKnight Lane Redevelopment Project, a small neighborhood with 14 affordable, high-efficiency modular homes equipped with solar and battery storage to serve LMI tenants in Waltham, VT.[11] Solar+storage on the distribution grid can also serve LMI communities, as evidenced by numerous municipal resilient power projects supported by the Massachusetts Department of Energy Resources (DOER) through its Community Clean Energy Resiliency Initiative (CCERI).[12] This grant program supports municipalities and municipal utilities to develop solar+storage microgrids to provide resilient power services to critical community facilities, including police stations, communications centers, hospitals, public shelters, and water treatment facilities. LMI communities were eligible for larger grants through this groundbreaking state program.

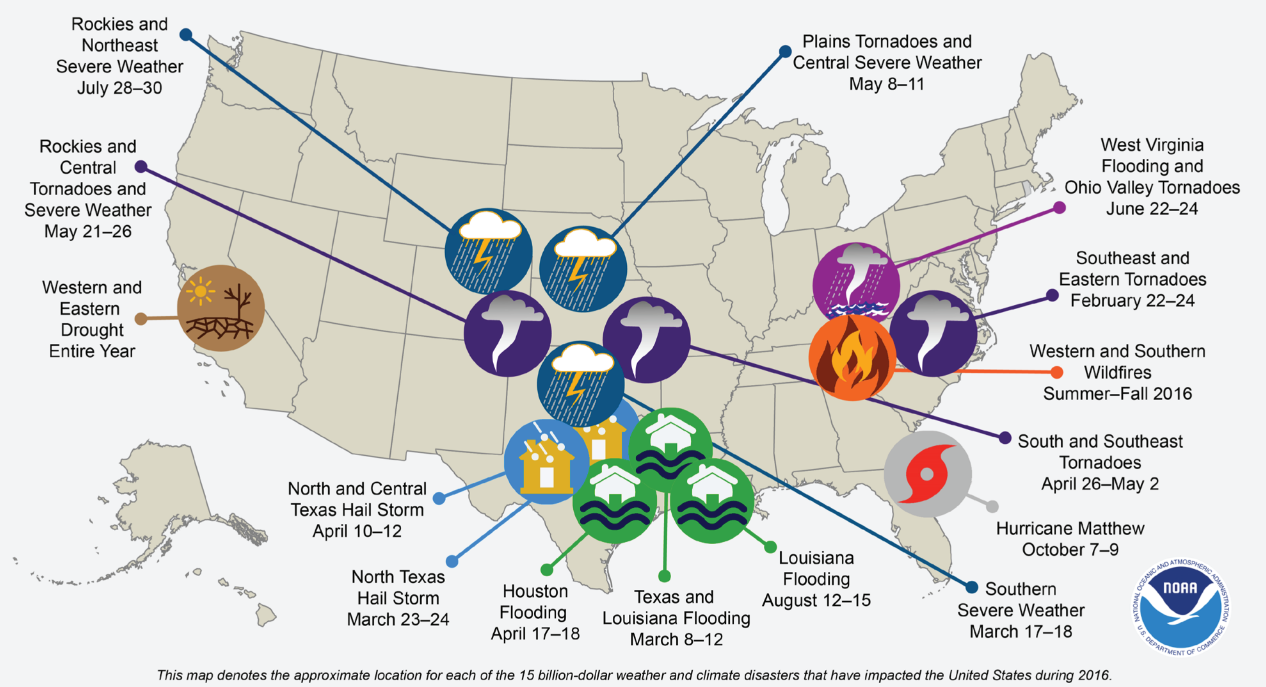
BOX 3

Resilient Power Efforts After Superstorm Sandy

Superstorm Sandy in 2012 was not the first extreme weather event to wreak havoc on the Northeast electric grid, but it did raise awareness of certain facts—that communities are vulnerable to electric grid outages, that these outages are frequently caused by natural disasters, that low-income communities are often the hardest hit and least able to quickly recover, and that such outages seem to be occurring more often and with increasingly costly results. Since 2012, more frequent and severe storms have been widely acknowledged as the "new normal," and states have begun to make serious investments in protecting power supplies for critical infrastructure such as first responder facilities, medical facilities, communications and transportations hubs, water pumping stations, water treatment plants, and public shelters. Early state resiliency programs included a $40 million microgrids grant program in Connecticut and a similar one in New York; the first-in-the-nation Energy Resilience Bank in New Jersey, funded with $200 million in federal disaster recovery funds; and the $40 million Community Clean Energy Resilience Initiative in Massachusetts.

Although these programs were clustered in the Northeast, there is no region of the country that has not faced threats to the electric grid. The map below is produced annually by the National Oceanic and Atmospheric Administration (NOAA) and shows billion-dollar weather and climate disasters in 2016, including severe storms, wildfires, drought and flooding. Although certain types of natural disasters occur more frequently in some areas of the country than in others, no state is exempt from natural disasters, and all states could benefit from resilient power for critical community facilities.

FIGURE 6: **U.S. 2016 Billion-dollar Weather and Climate Disasters**



This map denotes the approximate location for each of the 15 billion-dollar weather and climate disasters that have impacted the United States during 2016.

SECTION 4

Policy Tools

In 2017, Clean Energy Group published *A Resilient Power Capital Scan: How Foundations Could Use Grants and Investments to Advance Solar and Storage in Low-Income Communities*. This report, which was intended to help foundations direct their philanthropic efforts, identified five market barriers to the deployment of solar+storage technologies in low-income communities:

Barrier 1: Need for an integrated development finance model to overcome finance gaps in this underserved market.

Barrier 2: Lack of internal capacity of portfolio owners, advocates, and public officials to develop resilient power projects.

Barrier 3: Insufficient energy data collection, policy research, and economic analysis to understand how to advance technology development in these markets.

Barrier 4: Need for additional capacity of technical services providers, project developers, and nonprofit intermediaries to reach low-income communities.

Barrier 5: Inadequate market rules, incentives, and regulatory policies to advance new solar+storage technologies in low-income markets.

The capital scan report proposes more than 50 investment interventions that could address these five primary barriers. Although the report is directed toward philanthropic organizations, many of these interventions could be adopted by states and municipalities.

This guide focuses primarily on state and municipal solutions to Barrier 5: that is, policy tools that can help to address inadequate market rules, incentives, and regulatory policies. These tools are used by states and municipalities to support a variety of clean energy deployment, but our focus is on how these tools can be directed and adapted specifically to support solar+storage in LMI communities.[13]

Although the addition of energy storage to PV systems can provide important financial and resiliency benefits for LMI communities, it is not easy to implement. Currently, the compensation mechanisms available to energy storage providers are inadequate. Consequently, many benefits of energy storage are not fully realized or are not considered cost effective. In the long term, state policy can support the development of markets, the revision of regulations, and the maturing of the energy storage industry. In the short term, states and municipalities can design incentive programs to compensate for market barriers and the lack of compensatory mechanisms.

In recent years, numerous state policies and programs have been established to support energy storage deployment. These have included grant programs, rebates, adders and multipliers, procurement mandates, financing mechanisms, incentives, and technical assistance. Only a few have included targeted support for LMI communities; however, it is easy to see how many of these mechanisms could be designed to provide added support for solar+storage projects serving LMI customers.

This section reviews the various types of supports that states and municipalities can use to promote solar+storage benefiting LMI communities:

- Grants
- Rebates
- Incorporating Solar+Storage into Existing Programs
- Utility Mandates/Procurement
- Portfolio Standards
- Tax Incentives
- Alternative Ownership Structures
- Financing
- Clean Energy Financial Institutions
- Market-Based Tools and Regulatory Reform
- Technical Assistance, Tools, and Resources

The compensation mechanisms available to energy storage providers are inadequate. Consequently, many benefits of energy storage are not fully realized or are not considered cost effective.

Each of these topics is covered in a separate section of this guide, but there is some overlap between sections. For example, "incentives" is a broad term that can refer to a number of types of programs including various kinds of tax incentives, development zone programs, tariffs, and clean energy/emissions reduction/energy efficiency credits. Grants and rebates are sometimes considered types of incentive, but for the purposes of this guide, we consider "incentives" to be tax incentives and have broken out the categories of grants, rebates, and other non-tax incentives into their own sections.

It is important to note that while this guide discusses each of the various policy tools separately, best results have been obtained when states combine different policy tools into a comprehensive suite of policies and programs. For example, in California, an ambitious utility procurement mandate combined with a useful incentive program (the Self-Generation Incentive Program, or SGIP) has supported solar+storage deployment; Massachusetts is working to put together a similarly comprehensive program based on recommendations from the state's groundbreaking report, *State of Charge*.[14]

© Bright Power

Via Verde /The Green Way housing development, Bronx, NY.

Equally, it is important that state programs supporting solar+storage not preclude developers and project owners from accessing value streams from markets that may be available to them. An example of this would be a grant program that awards project construction grants to municipalities for projects in LMI communities, but requires the municipal recipients of the grants to own the storage equipment. Because municipalities cannot directly access federal tax incentives for solar and storage, this ownership requirement effectively precludes a project from taking advantage of federal tax incentives worth 60 percent of the capital investment over five years of project operation (see section on tax incentives). By allowing grant recipients to procure services from third-party owners, (for example, through lease-to-own or ownership flip contracts) the state would be able to reduce its own per-project grant costs and instead allow grantees to make use of federal resources. Similarly, grant programs that preclude grantees from using energy storage equipment to provide services to ancillary services markets limit the ability of projects to access available revenue streams.

More details on these policy tools may be found in the Clean Energy Group publications *What States Should Do: A Guide to Resilient Power Programs and Policy* and *What Cities Should Do: A Guide to Resilient Power Planning*.

GRANTS

Grant programs (sometimes called competitive solicitations) are among the easiest ways for a state or municipality to support clean energy projects, and they are often the first method used when states begin to address energy storage. They work well when the goal is to demonstrate and learn more about new or emerging technologies and/or applications.

There are numerous ways to ensure that a grant program will result in proposals that would benefit LMI communities, even if the overall program is not exclusively directed toward LMI communities. For example, a portion of the overall program budget can be set aside for projects that include LMI components. Grant award adders can be included for projects that meet specific criteria, such as serving LMI customers, so that these projects receive a larger award. Alternately, the solicitation can specify relevant weighting criteria that will be used in selecting which proposals receive awards (for example, extra points will be awarded to projects that serve LMI communities).

Advantages of grant programs include:

- The agency administering the program has a high degree of control over the projects that result.
- Competition for grants helps to ensure high-quality projects, with a good chance of success.
- Grant programs are voluntary and time-limited, and thus tend to be less controversial than compulsory programs such as procurement mandates, or long-term supports such as rebates or tax incentives.
- Grant programs can include claw-back provisions, which allow an issuing entity to recapture already disbursed grant funds if projects are not completed on time or to specifications.
- It is relatively easy to provide added incentives within a grant program for projects that serve LMI communities; for example, by scoring such project proposals higher, indexing the size of individual grants to community income levels, reserving a portion of the program budget for LMI projects, or offering an adder or multiplier for such projects.
- Awards can include technical assistance provisions to help to ensure projects succeed.
- Awards can include requirements for monitoring and verification, data collection, and knowledge sharing. Such requirements can help to make public information on project economics and operational data that would otherwise remain private. This can be helpful in informing follow-on projects and helping the developer community to become more comfortable with new technologies and applications. To ensure that these requirements are met, they can be structured as milestones in a milestone contract for disbursal of an award.

Example: *The Massachusetts Community Clean Energy Resiliency Initiative*

REBATES

Rebates are commonly employed when a new technology becomes more established but still needs support to compete with more mature technologies or in immature markets. Whereas a grant program requires the state or municipality to evaluate each proposed project individually, a rebate program establishes a set of eligibility requirements and rebate rates; once these are established, all eligible project investments qualify for the rebate (within budgetary limits).

A solar+storage rebate program could be targeted to support projects benefiting LMI communities by the addition of adders, multipliers, or carve-outs for projects that meet specific criteria, such as those within defined economic development zones or those supporting affordable housing facilities.

Some early-adopter states that began by supporting solar+storage demonstration projects through grants are now looking toward rebate programs to help support the emerging solar+storage industry until markets become self-sustaining. For example, energy storage programs are beginning to evolve from grant programs to rebates in California, Massachusetts, and New Jersey.

Advantages of rebates include:

- Rebates are easier to administer with faster turnaround on proposals, since the issuing agency is not required to choose between competing proposals. On the other hand, they give the issuing state or municipality less control over outcomes.
- Rebates tend to be more favored by developers, because they offer a guaranteed result rather than a competition with an uncertain outcome.
- Energy storage may be added as an eligible technology into existing solar or energy efficiency rebate programs (see below for "Incorporating Solar+Storage into Existing Programs"). This provides a fast way to provide incentives without developing an entirely new program and can help target a pool of developers that may be familiar with the existing program.
- Claw-backs are usually not needed, since rebates are typically awarded after the project is complete.
- As with grant programs, rebates can incent or require projects to serve LMI communities. Rebate programs should incorporate a well-defined set of performance standards that must be met in order to qualify for the rebate.
- Rebates can include requirements for monitoring and verification, data collection, and knowledge sharing, but some of these may be difficult to enforce once the rebate has been awarded.
- Rebates tend to work well for smaller BTM systems that can use off-the-shelf components. They may work less well for larger, more complicated projects, such as microgrids, that require custom engineering, as it can be difficult to prescribe eligible technologies and operational requirements for such projects.
- Rebates generally present relatively low risk of project failure, since eligible equipment will have a proven track record. However, issuing agencies may want to require warranties for rebate-eligible equipment.

- Rebate projects should require little technical assistance, since rebate programs generally assume the technology is well understood and certified installers are available. However, providing a list of certified installers can help ensure that equipment is installed correctly and meets performance standards.

Example: *The New Jersey Renewable Electric Storage Program*
Example: *The California Solar Initiative Multifamily Affordable Solar Housing (MASH) Program*
Example: *The California Self-Generation Incentive Program*

INCORPORATING SOLAR+STORAGE INTO EXISTING PROGRAMS

Many states have existing clean energy and/or energy efficiency programs that support solar PV. Incorporating the relatively new technology of energy storage into these existing programs may be easier and more effective than creating a new program. Furthermore, the inclusion of energy storage into existing programs signals its importance as an enabling technology for that program's goals. Energy storage can be an important enabler of many social goals important to LMI communities, including cost reduction, wealth creation, public health, resiliency, and renewables integration.

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In 2016, Massachusetts clean energy agencies released a landmark study of energy storage opportunities in the state.[15] The Massachusetts *State of Charge* study included numerous recommendations for storage to be incorporated into existing programs. Notably, it recommended incorporating storage into the state's existing Alternative Energy Portfolio Standard (APS), its solar incentive program, and its three-year Energy Efficiency Plan. These recommendations provide examples of how solar+storage can be integrated into existing programs and targeted toward LMI communities.

Of the three recommended Massachusetts programs noted above, the new solar incentive program, called the Solar Massachusetts Renewable Target (SMART),[16] is the closest to being fully developed and provides a good example of how storage can be integrated into an existing clean energy program with added LMI incentives. As proposed, SMART, which replaces previous Solar Renewable Energy Certificate (SREC) programs, will include a new adder for solar systems that incorporate energy storage, both at distributed and utility scales. The adder is variable and is structured to provide a larger benefit for storage systems with larger capacity ratings and longer discharge times. The program also provides adders for other social goods such as solar systems benefiting LMI communities, community solar systems, and those developed on brownfields. The adders may be stacked; for example, a developer could take advantage of three adders by installing a community solar+storage system in an LMI community.

Additionally, Massachusetts is considering amending its alternative energy portfolio standard to include battery storage; if this is done, projects receiving energy storage adders under the solar incentive program may also generate Alternative Energy Certificates (AECs) that will be transferred to electric distribution companies to be used towards APS compliance—a potential additional source of revenue for solar+storage installers.[17]

Advantages of incorporating solar+storage incentives for LMI communities into existing programs include:

- Customers, developers, and other stakeholders may be more likely to adopt a new technology presented through a familiar program.
- Amending an existing program may be an easier lift than crafting a new program.
- It may be easier to take advantage of technological synergies, such as are presented by solar PV and energy storage, when the synergistic technologies are supported by a single program in a coordinated manner rather than in two separate programs.
- Incorporating energy storage into existing programs underlines the importance of this new technology to achieve the goals of existing programs and make existing resources available to support deployment. This can be particularly helpful when integrating energy storage with solar in the areas of energy efficiency, renewables deployment and integration, public health, and affordable housing.

Example: *The Massachusetts Next Solar Incentive Proposal*

UTILITY PROCUREMENT MANDATES

Utility procurement mandates can be employed by states or cities to meet goals for the deployment of clean energy resources. With this approach, utilities are generally required to meet defined procurement goals by a particular date. If they cannot meet these goals, they may be required to pay an alternative compliance payment (ACP) and these funds can then be used by state energy agencies for direct investment in clean energy.

Mandates for the procurement of energy storage resources are relatively uncommon and are just beginning to emerge. To date, only California and Oregon have established energy storage procurement mandates; and Massachusetts is in the process of developing energy storage targets for utility procurement. Puerto Rico has a requirement that any new utility-scale renewable generators be supported with energy storage. And in 2016, New York City announced an aspirational target of having 100 mWh of storage installed by 2020. The goals of the target are to extend the effectiveness of solar PV, increase resiliency, and help the city meet its greenhouse gas emissions reduction targets.

California's 1.3 GW energy storage procurement mandate focuses primarily on large-scale energy storage, but it also creates a precedent for smaller, BTM systems to be included as a carve-out within a larger utility mandate. It establishes specific procurement targets for storage on the transmission and distribution grids, but also at customer sites. (See Table 2.)

If small solar+storage systems are desired, it may be helpful to limit utility ownership of procured systems, especially distributed or BTM systems, as was done in California. This would provide a market for third-party developers, because utilities will need to procure third-party storage services in order to meet required targets. Some portion of BTM system targets can also be reserved or "carved out" for LMI communities.

It should be noted that utility procurement mandates, while useful to stimulate immediate, large-scale deployment and support market development, will be much more successful at a

TABLE 2: **California Energy Storage Procurement Target (in MW)**

Storage Grid Domain (POINT OF INTERCONNECTION)	2014	2016	2018	2020	Total
Southern California Edison					
Transmission	50	65	85	110	310
Distribution	30	40	50	65	185
Customer	10	15	25	35	85
Subtotal SCE	90	120	160	210	580
Pacific Gas & Electric					
Transmission	50	65	85	110	310
Distribution	30	40	50	65	185
Customer	10	15	25	35	85
Subtotal PG&E	90	120	160	210	580
San Diego Gas & Electric					
Transmission	10	15	22	33	80
Distribution	7	10	15	23	55
Customer	3	5	8	14	30
Subtotal SDG&E	29	30	45	70	165
Total (ALL THREE UTILITIES)	**200 MW**	**270 MW**	**365 MW**	**590 MW**	**1,325 MW**

California's energy storage procurement mandate includes procurement targets for customer-sited systems.

Source: California Public Utilities Commission, Decision 13-10-040, October 17, 2013

BTM scale if accompanied by incentives. This has been seen in California, where the utility mandate has worked in sync with the Self Generation Incentive Program (SGIP). A similar combination of utility procurement targets and state incentives is being developed in Massachusetts. The incentives can be structured to further support investment in LMI communities; for example, by providing targeted grants or by incorporating solar+storage into existing programs targeted at those communities, such as energy efficiency and affordable housing programs.

Advantages of utility procurement mandates include:

- Mandates shift the burden of investment and risk to utilities and third parties.
- Mandates can create enormous amounts of investment. The California energy storage procurement mandate requires utilities to procure 1,325 MW of advanced storage by 2020; 749 MW have been procured to date.
- Mandates can be structured to ensure that distributed resources receive a portion of investment dollars, and that some portion of overall investments serve social purposes, such as benefitting LMI communities.
- Mandates may be structured such that alternative compliance payments must be made by utilities unable to meet procurement targets. These payments can be used by states to support deployment of distributed clean energy technologies.

BOX 4

Alternative Ownership Structures

Alternative ownership structures allow LMI communities to benefit from solar+storage without directly incurring the costs and risks of ownership. They can also provide a way for entities without a tax appetite to take advantage of federal tax incentives available for solar+storage investments. In some cases, they offer a solution to the split incentive problem discussed above.

Examples of alternative ownership structures are third-party ownership, including equipment leases, lease-to-own, and ownership flip arrangements; municipal and community-owned projects; utility-owned projects on the distribution grid; and virtual power plants.

Third-party ownership is commonplace for solar PV, but such ownership structures are only beginning to emerge for energy storage. However, there are several companies (and some utilities) that now offer a solar+storage lease package. This is similar to a solar lease, in that a third party owns, maintains and operates the system, sharing benefits with the host site.

A powerful structure for municipal and nonprofit entities can be a lease-to-own or flip structure. These structures provide a way for a third party to own the project for a specified period of time, after which ownership flips to the host. This can provide a method for the project to benefit from the federal investment tax credit (ITC) and accelerated depreciation, even if the host and eventual owner does not have a tax appetite. Nonprofit hospitals, schools, churches, municipal facilities (such as wastewater treatment plants) and municipal utilities can all benefit from this sort of structure.

In many cases, however, the intended beneficiaries of the project do not own property. In this case, a municipal or community ownership structure may be preferable. These structures are similar to a community solar project, in that the project is sited at a location remote from its beneficiaries or on property not owned by them. The beneficiaries own shares in the project and receive cost-savings in proportion. The project can be sited on a municipal property or private property and, in addition to providing energy cost savings to shareholders, can also provide community resiliency benefits; for example, by supplying backup power to a municipal public shelter. This sort of project structure also provides a method to overcome the split incentive problem.[18]

Such projects need not be located far from their beneficiaries; in some cases, affordable housing complexes provide sufficient rooftop or common area in which to locate solar+storage. For example, adding energy storage to community solar on multifamily affordable housing, with benefits shared between landlords and tenants, has been contemplated in the California Multifamily Affordable Housing Solar Roofs Program (AB 693).[19]

Another way to provide benefits to LMI communities is through utility-owned projects that provide resilient power to critical public facilities that serve LMI residents, such as shelters, fire and police stations, and hospitals. Examples of utility ownership in public benefit projects include the Green Mountain Power solar+storage microgrid in Rutland, Vermont, which provides resilient power to

Sterling Municipal Light Department's Energy Storage Project groundbreaking, Sterling, MA.

a school serving as a public emergency shelter;[20] and the Sterling Municipal Light Department microgrid in Sterling, Massachusetts, which provides resilient power to the police station and emergency dispatch center.[21] Both projects were supported with state and federal grants.

Another alternative ownership structure is the virtual power plant. This is an arrangement whereby a utility makes use of aggregated BTM solar+storage systems to realize cost savings, and these cost savings (often from reduced capacity and transmission costs) help to pay for the systems. There are various ownership arrangements that can work—the utility can own the batteries, or a third party can own them. In either case, LMI tenants enjoy the resilient power benefits while the utility and its ratepayers enjoy cost savings. This structure combines the advantages of centralized controls with the benefits of distributed, BTM resources.

An example of this sort of arrangement is the McKnight Lane Redevelopment project in Waltham, Vermont. In this case, the utility, Green Mountain Power (GMP), owns 14 6–kW Sonnen batteries located in 14 high-efficiency, affordable modular rental units. The units, each with rooftop solar, are owned by a community trust, which rents them at sub-market rates to low-income tenants (the rent includes electricity). GMP has the ability to dispatch the batteries remotely during monthly peak demand hours to reduce its capacity and transmission services cost obligation to New England ISO. The tenants enjoy resilient backup power at no added cost, and because the units are zero net energy, there is no annual cost to the property owner for electricity.[22]

PORTFOLIO STANDARDS

An alternative energy or renewable portfolio standard (RPS) is a requirement that a certain percentage of electricity in a utility or electricity supplier's portfolio be generated by eligible technologies, usually renewable or high-efficiency resources. More than half the states currently have an RPS, and some also have energy efficiency portfolio standards. Solar+storage systems can be included in any of these portfolio standards as an eligible technology, and added incentives or carve-outs within the portfolio standard can be used to further target these technologies toward LMI communities.

Although many RPSs simply set an overall percentage target, some go further in defining sub-targets for particular kinds of resources. For example, New York has a customer-sited tier within its RPS, as well as a geographic balancing program that is essentially a carve-out within the RPS for renewable deployment in downstate (urban) regions. These examples show that RPSs can include BTM systems and can be directed to benefit specific communities.

Often, electricity suppliers demonstrate compliance with RPSs by purchasing renewable energy certificates (RECs). RECs are created when electricity is generated from an eligible resource. An electricity supplier needs to purchase a sufficient number of RECs to achieve compliance with the RPS target for that time period. A state can distinguish between different resources within an RPS and can promote certain specific resources. For example, a state can require that a certain percentage of RECs filed be solar RECs (SRECs). The creation of specific solar+storage RECs, or a carve-out for RECs generated from LMI-sited resources, are mechanisms by which these resources could be targeted within a portfolio standard.

Advantages of portfolio standards include:

- RPSs are effective at stimulating deployment of eligible technologies. According to Galen Barbose of Lawrence Berkeley National Laboratory, "more than half of all growth in renewable electricity (RE) generation (60 percent) and capacity (57 percent) since 2000 is associated with state RPS requirements, though other drivers also likely contributed to that growth."[23]
- States with existing RPSs can add new technologies, such as energy storage, to their existing programs. Currently, California, Kansas, Ohio, and Montana accept energy storage in their RPSs. Massachusetts accepts flywheel storage in its Alternative Energy Portfolio Standard and is considering broadening the definition to include battery storage.
- RPSs may be structured such that noncompliant electricity suppliers make alternative compliance payments, which can then be used by the state to directly support the desired technologies and applications.

For more information on energy storage in RPSs and as stand-alone mandates, see the 2016 CESA report *Does Energy Storage Fit in an RPS?*

TAX INCENTIVES

The federal Investment Tax Credit (ITC) currently applies to both the solar and storage components of a solar+storage project, provided certain requirements are met. This has been a very important support for project development; however, the ITC is currently scheduled to drop from 30 percent to 26 percent in 2020, 22 percent in 2021, and finally to 10 percent for commercial projects (and 0 percent for residential projects).

Many states offer state tax incentives for clean energy projects, including both renewables and energy efficiency measures. State tax incentives such as these could be amended to include solar+storage as an eligible technology.

However, tax incentives can present problems for some entities that may seek to develop solar+storage projects in LMI communities. Many likely developers of these projects, such as municipalities and nonprofit organizations, are not taxed and therefore are not able to take advantage of tax credits directly; and smaller for-profit developers, although they are taxed, may not have the tax appetite necessary to fully benefit from such incentives. For these reasons, a third-party financier or bank will often have to be brought into a project as a financial partner so that the tax incentives can be applied. In so doing, the value of the tax credit to the developer is reduced, because the benefits must be shared with the financial partner. However, the outcome for the project, in terms of both better economics and lower risk, can be substantial by comparison with a project that leaves tax incentives on the table due to an inability to access them. There is also a long-term benefit to the industry, in that such financial arrangements help to familiarize the investment community with solar+storage and with developers of LMI projects, and this can help to improve the ability to finance future projects.

Green Mountain Power's Stafford Hills solar+storage microgrid in Rutland, VT.

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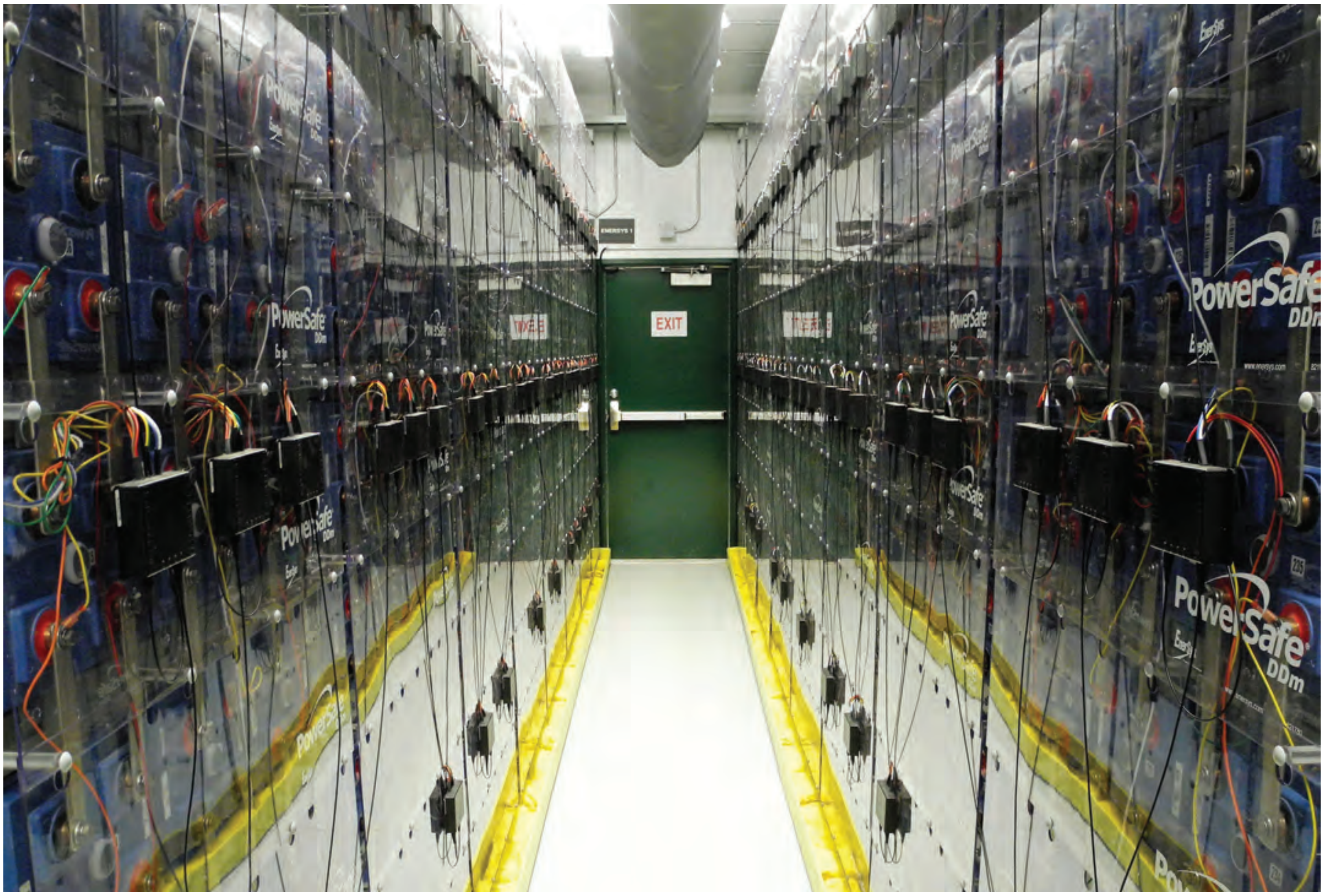

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Battery storage system at GMP's Stafford Hills microgrid, Rutland, VT.

Advantages of tax incentive programs include:

- Tax incentives can leverage market structures and help markets to develop by encouraging the involvement of banks and financiers with tax appetites.
- Tax incentives can be more developer-friendly than grants, as they provide a more predictable and reliable form of project support.
- Compared to competitive grants or rebates, tax incentives are less time-consuming for agency staff to administer.
- Including solar+storage in existing tax incentive programs can be simpler than designing a new program specific to solar+storage, and provides a way to tie the two technologies together (for example, an existing solar tax incentive can be amended to include solar+storage systems).
- Incentives can be set with precision and result in predictability for both developers and ratepayers (however, because there is no way to know how many developers will take advantage of a tax incentive, the impact on government revenues can be difficult to predict).

FINANCING

Along with sharp declines in manufacturing costs, the rise of third-party leasing and other financing mechanisms have fueled the explosive increase in deployment of rooftop solar PV in the U.S. It is now possible, in some places, to acquire a rooftop solar system at no initial cost, and to start realizing energy cost savings in the first month. Given the synergies between solar and battery storage, it is no surprise that solar companies have begun to partner with battery companies to offer residential and commercial solar+storage systems, with the cost of the batteries wrapped into the overall system financing.

However, both for solar-alone and for solar+storage systems, these sorts of financing opportunities have largely been limited to affluent customers with high credit ratings, who own their own properties. It has been much more difficult for LMI households and businesses to access financing, due to low rates of home ownership, split incentives in rental housing, and low credit scores.

In order to get the benefits of energy storage to LMI communities, and in order to move markets beyond demonstration projects and government grants, it will be important to overcome financing barriers and support new financing mechanisms in these communities. In general, this means using public resources to provide financing directly or to lower risk for other financiers.

States and municipalities have many innovative financing options that can be put to use to support solar+storage deployment in LMI communities.[24] These include various combinations of:

- Bond Financing (General obligation bonds, Morris model financing, 501(c)(3) bonds, housing bonds, school construction bonds, disaster recovery/climate resiliency bonds, PACE bonds)
- Clean Energy Financial Institutions (State green banks/energy resilience banks, warehouse credit facilities)
- Public and Private Ownership Structures (third-party ownership with PPA, municipal improvement districts, utility ownership)
- Credit Enhancements (Public benefit funds, loan guaranty)

It should be noted that financing strategies alone are not a substitute for an integrated approach to solar+storage market development that includes not only a range of financing tools, but also market building support to increase the capacity of project developers and portfolio owners; the collection and evaluation of performance data; and the good design of market rules, incentives and regulatory policies to advance solar+storage technologies in low- and moderate-income communities.

We review some examples of financing programs below. For more details, see Clean Energy Group's report, *Financing for Clean, Resilient Power Solutions*.

Bond Finance

States and municipalities can use their bonding authority to create resources for clean energy finance. Some types of bonds that may be useful include municipal general obligation bonds, Morris model financing, 501(c)(3) bonds, school construction bonds, disaster recovery/resiliency bonds and housing bonds. We do not discuss all of these various types of bonds here, but use housing bonds as an example of how state and municipal bonds can be used to support clean energy in LMI communities.

States can offer housing bonds specifically for clean energy deployment in affordable housing. For example, in 2016 New York State announced nearly $100 million in new green bonds to drive the development of housing that has a positive impact on the environment and climate. These bonds are certified by The Climate Bond Standards Board, on behalf of the international not-for-profit Climate Bonds Initiative.[25]

Municipalities can also issue sustainable housing bonds and can target LMI communities. For example, New York City Housing Development Corporation (HDC) offers Sustainable Neighborhood Bonds, which are intended to support affordable housing projects that "contribute to the stability and economic diversity of neighborhoods." However, these bonds are also intended to address environmental issues, and most projects funded under the program are required to meet Enterprise Green Communities Criteria**,** a comprehensive green building framework designed for affordable housing. Although the Green Communities Criteria does not specifically address solar+storage, it does include energy resiliency. According to HDC, this is the first social bond for affordable housing in the United States.[26]

Developers can access tax-exempt housing bonds to finance or refinance the acquisition and rehabilitation of existing low-income or elderly housing, or for the construction of new projects, provided at least a portion of the units are allocated for LMI tenants. Housing bonds can be used for affordable multifamily housing but are also applicable to assisted living facilities that provide supportive services to the elderly, the disabled and the chronically homeless.

Credit enhancement/loan guarantees

Because investments in LMI communities may be viewed as carrying greater risk, and because energy storage is still an unfamiliar technology to many financiers, it can be difficult for developers to finance solar+storage projects in LMI communities. Credit enhancement is a way of reducing risk and making such investments more attractive.[27] Essentially, credit enhancement provides lenders with an assurance that loans will be repaid, through the application of additional collateral, insurance, or a third party guarantee. This can help developers to obtain financing and can also reduce the cost of borrowing.

Governments at all levels—municipal, state and federal—offer credit enhancement mechanisms as a matter of course. Increasingly, these financial tools are being used to support clean energy deployment. As an example, the U.S. Department of Energy, under the Title XVII program, Section 1703, provided billions in loan guarantee funds for distributed energy projects that reduced greenhouse gas emissions through the use of new technologies.[28]

States and municipalities can also provide loan guarantees. Nearly half of US states have established a system benefit charge (SBC), which is a small surcharge on electric bills. States

BOX 5

PACE Assessments

One specific type of municipal bonding authority is PACE (property-assessed clean energy) assessments. Municipal PACE programs provide financing for clean energy upgrades that are repaid via the borrower's property tax bill. PACE programs require both state authorization and municipal action. Unfortunately, because PACE financing typically makes the clean energy assessment senior to other liens and non-tax debt on the property, PACE programs have proved difficult to implement due to lienholder concerns (with some exceptions and solutions explained below). Commercial PACE transactions have been easier to complete than residential PACE assessments because in the case of commercial properties, existing lienholders are notified in advance and provide prior consent to the PACE assessments.

The good news for LMI communities is that common areas within multifamily affordable housing properties frequently are billed as commercial rather than residential properties, and thus may be able to use commercial PACE loans. A good example of a commercial PACE program is the Connecticut Green Bank's C-PACE program.[29]

For residential properties the situation is more complex. Until recently, both the Federal Housing Authority and Federal Housing Finance Agency (FHFA) had declined to insure mortgages on properties with PACE assessments. In August 2016, the FHA issued a guidance document reversing its previous stance and agreed to insure mortgages with PACE assessments, so long as these mortgages meet five conditions—primarily that PACE loans cannot have superior priority lien status to the mortgage, except in the event of a default.[30] However, the FHFA, which directed Fannie Mae and Freddie Mac to avoid buying mortgages on PACE-encumbered properties in 2010, remains opposed to them.[31] Since some 80 percent of residential mortgages are insured through FHFA programs, this remains a barrier to most residential PACE programs.[32]

Some states have found ways around this barrier, generally by making PACE liens subordinate to first mortgages and by establishing loan loss reserve funds to backstop investments. Examples of such programs include the following:

- Vermont statutorily subordinates PACE liens to first mortgages and has established debt service (e.g., loan loss) reserve funds.[33]
- California has established debt service reserve funds.[34]
- Maine subordinates PACE liens to general property taxes and primary residential mortgages, regardless of when the mortgage was recorded.[35] Maine's PACE program also treats the transaction as a loan that runs with the property, not as a tax assessment; lends through a closed lending market; and has a revolving loan fund.[36]

The U.S. Department of Energy has recently revised its *Best Practice Guidelines for Residential PACE Financing Programs*. The guidelines provide specific program design recommendations for low-income households.[37]

commonly use SBC funds to support clean energy deployment, either directly by a state-administered program, or sometimes through a utility or nonprofit contracted to administer the funds. However, states are also beginning to use these funds to provide credit enhancement, backing bonds that attract private investment. For example, Hawaii has a program to finance clean energy projects by combining utility on-bill repayment for participating customers with bond financing, which has been credit enhanced with (backed by) the utility surcharge (SBC). This is a way for the state to access capital markets with an investment grade security that does not require the state's general obligation guarantee.

Municipalities have opportunities to provide credit enhancement for clean energy projects through their bonding authority. An example is the Morris Model, which has been used numerous times in New Jersey to support solar deployment on public buildings. The way this works is that the municipality announces a request for proposals (RFP) for solar development on a public building; issues a low interest rate government bond to finance development costs; and transfers that low-cost capital to the winner of the RFP in exchange for a low-priced power purchase agreement (PPA). The private developer builds, owns, operates and maintains the solar project, selling the electricity generated to the municipality at a reduced cost. The municipality also enters into a lease-purchase agreement with the developer.

In this model, the municipal bonds are "double-barreled," meaning they rely on both project revenue (from the PPA) and a county general obligation guaranty, which is a pledge from the county to pay bondholders in case of a default.

This model could be adapted to provide solar+storage on public housing facilities, schools, or other public infrastructure in LMI communities. The simplest way to do this would be

Aerial shot of the partially completed McKnight Lane affordable housing development, which was completed in Fall 2016.

© Dan Cox, Abbott Films

for the municipality to select a developer that offers a combined solar+storage product (rather than making two separate awards to two separate developers). The PPA price would need to reflect the added cost savings and revenues the developer might obtain through use of the energy storage component of the system, for example, by providing frequency regulation or participating in a demand response program. Alternately, the batteries could be used to reduce the host facility's demand charges. If a resilient power benefit were to be provided to the host facility, islanding equipment would be specified in the RFP, and contract language would be needed to ensure that the batteries were not discharged prior to potential natural disasters that could result in grid outages, for example, prior to a predicted hurricane or ice storm.

If a resilient power benefit were to be provided to the host facility, islanding equipment would be specified in the RFP, and contract language would be needed to ensure that the batteries were not discharged prior to potential natural disasters that could result in grid outages, for example, prior to a predicted hurricane or ice storm.

Advantages of financing programs include:

- Finance programs can leverage existing market finance resources, for example, by providing credit enhancement.
- In many instances, finance programs can allow the state or municipality to reduce the amount of per-project subsidy compared to a grant or rebate program.
- Loans can be provided on a revolving basis, so that public funds are cycled back through the program to support multiple projects.
- Finance programs help familiarize banks and other financiers with solar+storage technologies, which can help speed the development of private financing tools to support the technologies.

For more details on clean energy finance, see the following publications:

- *Financing for Clean, Resilient Power Solutions*—A Clean Energy Group report (Oct. 2014)
- *Ramp Up Resilient Power Finance: Bundle Project Loans through a Warehouse Facility to Achieve Scale*—A Clean Energy Group concept note (Jan. 2015)
- *Reduce Risk, Increase Clean Energy: How States and Cities Are Using Old Finance Tools to Scale Up a New Industry*—A Clean Energy and Bond Finance Initiative report (Aug. 2013)

CLEAN ENERGY FINANCIAL INSTITUTIONS

Various types of financial institutions can be created to support clean energy deployment. These include green banks and warehouse credit facilities. The most common of these are state green banks (or, in the case of New Jersey, an energy resilience bank). The purpose of the green bank is to make financing available at favorable terms for eligible technologies and applications that would otherwise have difficulty attracting investment. Making solar+storage eligible, and providing loans at favorable terms for projects in LMI communities, can provide the kind of financing support more risk-averse banks may not provide. Green banks can also help to make traditional financing more accessible, for example by buying down interest rates.

However, the mere existence of a green bank does not mean that LMI communities will be served. Green banks typically have both financial and social investment criteria, the latter including such goals as greenhouse gas emissions reduction, support of renewable generation, and energy efficiency. But unless LMI goals are explicitly included in the investment criteria, LMI communities may not be served if they do not represent a financially attractive investment.

An example of a green bank that explicitly incorporates LMI investment goals is the New Jersey Energy Resilience Bank (ERB). Created in response to the devastation of Superstorm Sandy, the NJ ERB was capitalized using $200 million in U.S. Department of Housing and Urban Development (HUD) CDBG-DR funds, and as such, complies with HUD regulations pertaining to the use of these funds, including that "Priority… is placed on projects which serve low and moderate income communities or which create low or moderate income (LMI) employment, either part of which is referred to as the LMI National Objective."[38] Although state green banks or other clean energy institutions not capitalized using HUD funds may not be required to follow HUD LMI regulations, these can be useful guidelines to incorporate into a loan or finance program.[39]

Advantages of clean energy financial institutions include:

- Clean energy financial institutions can make financing available on a large scale and at favorable rates to projects that might otherwise not be able to attract financing.
- The presence of clean energy financial institutions in the market can help encourage the development of private financing for clean energy projects.
- Clean energy financial institutions can target resources toward LMI communities and those that have been affected by natural disasters.
- From the state's perspective, a green bank or energy resilience bank makes efficient use of public funds by leveraging private finance and by creating revolving loan funds that reuse capital to support numerous projects.

Example: *The New Jersey Energy Resilience Bank*

MARKET-BASED TOOLS AND REGULATORY REFORM

One way to support the development of a solar+storage industry that will serve LMI communities is to employ market-based and regulatory tools that not only improve the economics of the technology, but support the opening of existing markets and the formation of new ones.

Some analysts have observed that the commercialization of battery storage technology seems to be following a pattern similar to that of solar PV, with storage approximately where solar was 10-20 years ago. Like solar, energy storage (when paired with a renewable generator) is supported by the ITC and, in a few states, it is beginning to be incorporated into RPSs and grant and rebate programs. However, there are important differences between the two technologies. State support for energy storage is nowhere near as widespread as it is for solar

PV, and net metering programs do not support energy storage as they do solar, because storage is not an energy generator. Likewise, most existing clean energy portfolio standards do not include storage as an eligible technology.

However, energy storage can serve other sorts of energy markets, such as ancillary services markets and demand response programs, which solar alone cannot serve. These markets have only recently begun to open to distributed resources like BTM solar+storage.

Some of these markets are regulated on a regional basis by ISOs and RTOs, or federally by FERC. But states can also have some impact on the ability of smaller, BTM solar+storage systems to have access to markets. For example, state public utility commissions (PUCs) can direct utilities to streamline interconnection procedures for solar+storage systems, and allow small systems to participate in demand response programs.

An example of a state that has streamlined interconnection procedures is Vermont, which in 2011–2012 instituted a simplified 10-day permitting process for small solar PV systems. The system now includes a one-page registration form for net-metered systems of 15kW or less. If the utility does not raise interconnection concerns within 10 days, the application is "deemed granted." This streamlined system replaced a much lengthier process that could otherwise require public hearings for even small rooftop systems. Because solar permitting is a state function in Vermont, rather than a function of local governments, the process was amenable to change with a single law.[40]

Because solar+storage technologies are relatively new, they may trigger extra utility review procedures that can slow development timelines and add cost. Streamlined interconnection processes are therefore very valuable to developers.

Because solar+storage technologies are relatively new, they may trigger extra utility review procedures that can slow development timelines and add cost. Streamlined interconnection processes are therefore very valuable to developers. For example, a 2011 SunRun report found that local permitting and interconnection processes can add up to 20 percent to the installed cost of rooftop solar.[41]

Around the same time as it streamlined its small solar interconnection rules, Vermont also adopted a solar feed-in tariff (FIT) with an interesting feature: if a new solar system is located close to load, e.g. in urban locations, it does not count against the program cap of 122 MW. This is an example of another rule that could be adopted for solar+storage systems, using a similar logic—i.e., if systems are able to store excess solar generation for use during peak hours, these systems should not be limited by net metering or FIT caps.

By reducing soft costs and exempting urban systems from the FIT cap, Vermont made solar PV more accessible and less expensive, important attributes especially in LMI communities, which already face added access and financing obstacles. It would be relatively simple to provide the same sort of support for solar+storage systems.

Another way that states can help to promote and sustain markets for distributed solar+storage is to regulate utility ownership and use of the technology. In areas of the country where utilities are vertically integrated, or where an exception to deregulation rules has been made to allow utility ownership of energy storage (as was recently done in New York and Massachusetts), there is a danger that misuse of market power by utilities can shut the door on BTM systems. There is also the likelihood that investor-owned utilities will use solar+storage technologies for cost-reductions—a worthy goal—but will not take the additional step of making sure that social goods are also provided for. These are issues that a state PUC may be able to address. For example, the New York REV process enumerated specific conditions under which utilities may own energy storage. Among these is a requirement that storage benefit LMI communities.

Advantages of market-based and regulatory approaches include:

- Markets are the ultimate supporters of technologies. States and municipalities cannot provide limitless public support for solar+storage, but can provide temporary supports while working to open markets and level playing fields. Every small step toward market maturity provides long-term benefits for the industry and allows public funds to be directed elsewhere.
- Demonstration and pilot projects can be used to open markets. For example, the Beacon Flywheel project was the first utility-scale storage project to demonstrate the superior ability of energy storage to provide frequency regulation in PJM. That project led directly to a series of FERC orders opening the frequency regulation market to distributed resources and mandating pay for performance rules that in turn supported numerous additional energy storage projects in PJM.
- Enabling solar+storage to be compensated in open markets sends more accurate price signals and allows the technology to demonstrate its value. An example of this can be seen in demand response programs, which have been supported and enabled by FERC orders. Like other customer-sited resources, BTM energy storage can be aggregated and bid into open markets to provide services such as demand response and frequency regulation, if market rules allow this to happen. Doing so demonstrates that the technology can serve multiple applications and helps to establish a price for these services.

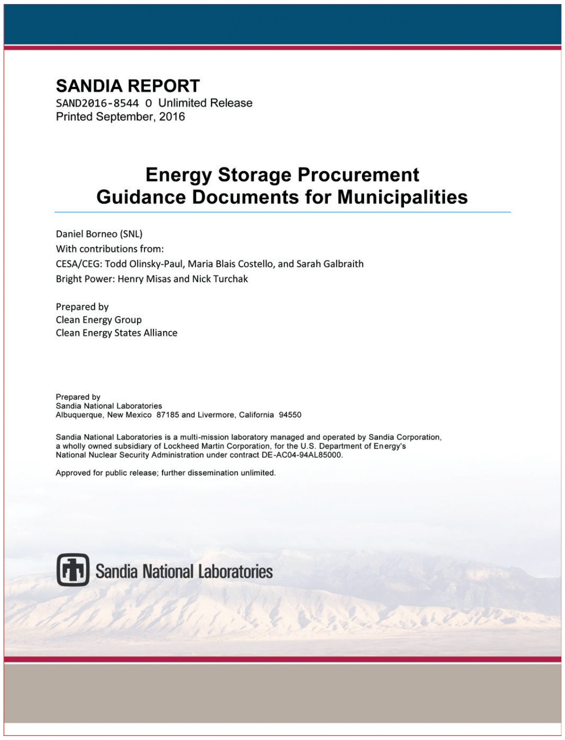
A good discussion of energy markets, and what states can do to help energy storage access those markets, can be found in the Massachusetts *State of Charge* report.

TECHNICAL ASSISTANCE, TOOLS, AND RESOURCES

In the aftermath of Superstorm Sandy, Massachusetts Department of Energy Resources (DOER) rolled out a $40 million Community Clean Energy Resilience Initiative (CCERI).[42] This was a grant program with a number of innovative features, including the fact that community per-capita income was included when grant eligibility caps were calculated (meaning that LMI communities were eligible for larger grants). The program also included a pre-proposal feasibility study grant opportunity, so that communities could get help in scoping out resilience projects. The idea was to help communities with new technologies and increase the odds that the state would receive high-quality grant applications.

The feasibility study grants were very important to many communities. Because solar+storage is a new technology, with potentially complex applications such as microgrids, many towns and cities do not have in-house engineers with experience working on these systems. In order to develop a good proposal for funding, the communities needed help to understand whether they had a good potential project, and to do preliminary scoping necessary to write a grant proposal.

However, pre-proposal feasibility studies of this kind turned out not to be sufficient to ensure successful project development. Communities face many post-award hurdles, from detailed project design to procurement to dealing with vendors to project construction and commissioning to data collection. In order for these resilient power projects to be successful, it was important for communities to have access to post-award engineering and economic technical assistance. Clean Energy Group and the Clean Energy States Alliance have provided free technical assistance to the Massachusetts DOER grantees, and we have also developed tools and resources to address some common needs, such as a procurement guidebook,[43] online project scoping tools, economic studies for various types of projects, and case studies of successful projects.[44] Technical assistance of these kinds is particularly important if solar+storage technologies are to make their way into LMI communities.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Guidance Documents for Municipalities

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There are numerous ways for states to provide technical assistance to support project grants, rebates or other incentives:

- States can provide publicly funded, project-specific technical assistance grants, either employing an engineering firm to provide services or allowing grantees to hire a firm of their choosing. These grants may provide for pre-application feasibility studies that will help applicants develop proposals for implementation grants, or they may provide support for more detailed project development, procurement and construction.
- States can invest in the development of tools and resources, such as online project scoping tools, tools to assist with project economic analysis, procurement guidelines, etc.[45]
- States can provide lists of qualified installers, project integrators, engineering firms, etc.[46]
- States can work with NGOs in the areas of housing and energy to educate them about solar+storage technologies and applications.
- States can fund pilot projects that will result in publicly available data and knowledge sharing, to inform future projects.[47]

Example: *The Massachusetts Community Clean Energy Resiliency Initiative*

SECTION 5
Conclusion

Supporting solar+storage deployments in LMI communities is not easy. But it is possible. It requires creative financing, effective policies, and stakeholder partnerships. Unfortunately, at this time there are relatively few examples of completed projects to emulate. Below are some take-aways from the variety of policies, programs, and projects that have been reviewed in this guide.

- Society's most vulnerable communities can reap many benefits from solar+storage, including energy cost savings, resiliency, and guarding against the devaluation of solar.
- Storage markets are underdeveloped, and many valuable services that can be provided by solar+storage from behind the customer's meter are not yet monetizable; but state policies and programs can help to develop markets for these technologies.
- Though costs are declining, solar+storage systems are expensive. But, in certain markets, solar+storage systems can pay for themselves, and in many cases can be a sound investment. Unless markets support the full monetization of all the benefits solar+storage can provide, and until standard third-party financing is widely available, public support will be needed to reduce project costs, risk, and the amount of needed up-front investment for LMI markets.
- There is no silver bullet. A policy suite incorporating a variety of approaches—grants or rebates, utility procurement standards, financing support, opening markets, soft cost reductions—is needed to move the needle.
- Incorporating storage into existing incentive programs that support solar deployment, such as SREC programs, solar incentives and energy efficiency subsidies, can be a fast and effective way to provide support for solar+storage; adders may be established to provide needed additional support for LMI projects. Energy efficiency programs, in particular, can represent a significant untapped resource that could support solar+storage deployment in LMI communities
- Technical assistance for solar+storage projects is important. While it is great for states to support projects financially, if technical support is not also provided, projects may not be successful.

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Sonnen residential battery.

- Utilities are important partners. BTM projects will need to be interconnected, and the most successful state programs have gone forward with the full participation, if not partnership, of utilities.
- Solar+storage enables numerous social goals, including emissions reductions, renewable generation, resiliency, economic development and improved public health. To date, however, it has rarely been incorporated into the numerous public policies addressing these issues, nor has its value been fully understood by many NGOs working in these areas. The incorporation of solar+storage into policy and programs addressing these goals will help in providing access to LMI communities.

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The Sustainable Solar Education Project provides timely information and educational resources to help states and municipalities ensure distributed solar electricity remains consumer friendly and benefits low- and moderate-income households.

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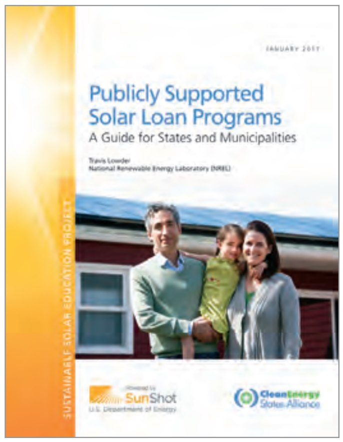
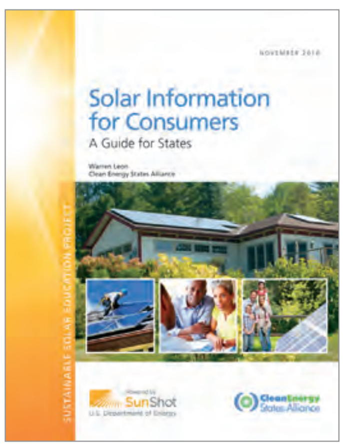


PUBLICLY SUPPORTED SOLAR LOAN PROGRAMS: A GUIDE FOR STATES AND MUNICIPALITIES

This guide describes general factors state and municipal governments should consider when assessing whether to launch a public solar loan program, explains various loan program design elements, and offers several case studies.

The accompanying webinar recording is available at *www.cesa.org/webinars/designing-publicly-supported-solar-loan-programs*.



SOLAR INFORMATION FOR CONSUMERS: A GUIDE FOR STATES AND MUNICIPALITIES

This guide explains why states should provide consumer information on solar, describes the types of information that can be useful, and points out existing educational efforts by states and other entities that provide models and useful resource information.

The accompanying webinar recording is available at *www.cesa.org/webinars/solar-consumer-protection*.

STANDARDS AND REQUIREMENTS FOR SOLAR EQUIPMENT, INSTALLATION, AND LICENSING AND CERTIFICATION: A GUIDE FOR STATES AND MUNICIPALITIES

This guide is intended as a starting point for program managers in states or municipalities who are developing or revising standards and requirements for installation, licensing and certification, equipment, and warranties for solar photovoltaic (PV) equipment and systems.

The accompanying webinar recording is available at *www.cesa.org/webinars/solar-equipment-installation-and-licensing-and-certification-a-guide-for-states-and-municipalities.*

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