Solar Power in Your Community

A guide for local governments on how to increase access to and deployment of solar PV.

U.S. DEPARTMENT OF ENERGY | Office of ENERGY EFFICIENCY & RENEWABLE ENERGY

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List of Acronyms

ACCESS	Achieving Cooperative Community Equitable Solar Sources
ACEEE	American Council for an Energy-Efficient Economy
AMI	area median income
BETTER	Building Efficiency Targeting Tool for Energy Retrofits
CBO	community-based organization
CCA	community choice aggregation
CECAP	Community-Wide Energy Climate Action Plan
CELICA	Clean Energy for Low-Income Communities Accelerator
CESA	Clean Energy States Alliance
ComEd	Commonwealth Edison
CWA	community workforce agreement
C-PACE	commercial property assessed clean energy
DER-CAM	Distributed Energy Resources Customer Adoption Model
DHA	Denver Housing Authority
DOE	U.S. Department of Energy
DOL	U.S. Department of Labor
DSIRE	Database of State Incentives for Renewables and Efficiency
ECM	energy conservation measure
EGLE	Environment, Great Lakes, and Energy
EJSCREEN	Environmental Justice Screening and Mapping Tool
EPA	U.S. Environmental Protection Agency
ETIPP	Energy Transitions Initiative Partnership Project
EV	electric vehicle
FCU	Fort Collins Utilities
FEMA	Federal Emergency Management Agency
FIT	feed-in tariff
FPV	floating photovoltaic
GEM	Greenlink Equity Map

GW	gigawatt
HBCUs	Historically Black Colleges and Universities
HOA	homeowner association
HVAC	heating, ventilating, and air conditioning
IBEW	International Brotherhood of Electrical Workers
ICAST	International Center for Appropriate and Sustainable Technology
ICMA	International City/County Management Association
InSPIRE	Innovative Solar Practices Integrated with Rural Economies and Ecosystems
IREC	Interstate Renewable Energy Council
ITC	investment tax credit
JATC	Joint (labor-management) Apprenticeship Training Committee
kW	kilowatt
kWh	kilowatt-hour
LA100	Los Angeles 100% Renewable Energy Study
LBNL	Lawrence Berkeley National Laboratory
LEAD	Low-Income Energy Affordability Data
LEAP	Communities Local Energy Action Program
LIHEAP	Low Income Home Energy Assistance Program
LMI	low- to moderate-income
MFAH	multifamily affordable housing
MSIs	Minority Serving Institutions
MW	megawatt
MWh	megawatt-hour
NAACP	National Association for the Advancement of Colored People
NABCEP	North American Board of Certified Energy Practitioners
NABTU	North American Building Trades Unions
NASEO	National Association of State Energy Officials
NCSP	National Community Solar Partnership
NEM	net energy metering
NREL	National Renewable Energy Laboratory

NSRDB	National Solar Radiation Database
NYSERDA	New York State Energy Research and Development Authority
OIE	U.S. Department of Energy Office of Indian Energy Policy and Programs
ORISE	Oak Ridge Institute for Science and Education
PACE	property assessed clean energy
PBIs	production-based incentives
PLA	project labor agreement
PPA	power purchase agreement
PTC	production tax credit
PV	photovoltaic
R-PACE	residential property assessed clean energy
REAP	Rural Energy for America Program
REC	renewable energy certificate
RFP	request for proposals
RPS	renewable portfolio standards
SAM	System Advisor Model
SEI	Solar Energy International
SEIA	Solar Energy Industries Association
SEIN	Solar Energy Innovation Network
SFCHA	Santa Fe County Housing Authority
SLOPE	State and Local Planning for Energy
SolarAPP+	Solar Automated Permit Processing
Solar TRACE	Solar Time-Based Residential Analytics and Cycle Time Estimator
SPOT	State Policy Opportunity Tracker
SREC	solar renewable energy certificate
STEM	science, technology, engineering, and mathematics
USAID	U.S. Agency for International Development
USDA	U.S. Department of Agriculture
VNEM	virtual net energy metering
WAP	Weatherization Assistance Program

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INTRODUCTION

Installed solar photovoltaic (PV) capacity has grown rapidly in the United States over the past decade, reaching nearly 74 gigawatts-AC as of the end of 2020. Approximately one-third of this capacity (28 gigawatts) is distributed PV, including residential, community, and commercial solar installations (Davis et al. 2021). A combination of technology cost declines, federal incentives, and state policy support have driven increased deployment and enabled more communities to access the benefits of PV. Increasingly, solar is playing an important role in local plans such as resilience planning, sustainability planning, and climate action planning.

Despite substantial market growth, barriers to PV adoption continue to pose challenges for local governments and stakeholders seeking greater PV utilization. Many of these barriers disproportionally impact low- to moderate-income (LMI) households and under-resourced communities[1] (Heeter et al. 2021a). The access of LMI households to PV is hindered by several factors, including the inability to afford the upfront cost of PV systems, lack of home ownership, and inadequate income or credit to qualify for solar financing. Households and businesses alike may face additional barriers, such as complicated procedures for permitting and connecting systems to the grid, financing challenges, and a lack of awareness of solar energy solutions. Local governments are uniquely positioned to remove many of the barriers to widespread solar adoption and make solar energy more affordable and accessible for their residents and businesses, as well as for local universities and government buildings.

The U.S. Department of Energy (DOE) designed this Solar Power in Your Community guidebook to assist local government officials and stakeholders in boosting solar deployment. The 2022 edition contains updated case studies with approaches to reduce market barriers that have been field tested in cities and counties around the country. Many examples are the direct result of the SolSmart Program, a designation program supported by DOE's Solar Energy Technologies Office recognizing municipalities, counties, and regional organizations that are addressing market barriers and making it faster, easier, and more affordable to go solar.[2]

This guidebook highlights new technologies and strategies to maximize the benefits of solar to all communities, such as combining solar with energy storage to improve resilience. Many of these technologies are highlighted in Figure 1. It also emphasizes strategies for improving the equity and workforce aspects of solar deployment at the local level. Compared with the previous edition of the guidebook, this edition omits certain topics—such as utility interconnection standards and electricity rate structures—that are typically less within the control of local

[1] The Clean Energy States Alliance defines "under-resourced communities" as communities that have high proportions of LMI residents and generally receive below-average services and financial resources from the government. Many, but not all, comprise an above-average number of people of color and immigrants. This guide references under-resourced, LMI, and front-line communities as well as communities of color.

[2] For more information about SolSmart, the program's technical assistance resources, designated SolSmart jurisdictions, and local accomplishments, visit https://solsmart.org/.

governments. This edition also omits some topics that have declined in importance since the previous edition was published and are not as relevant in the market today.

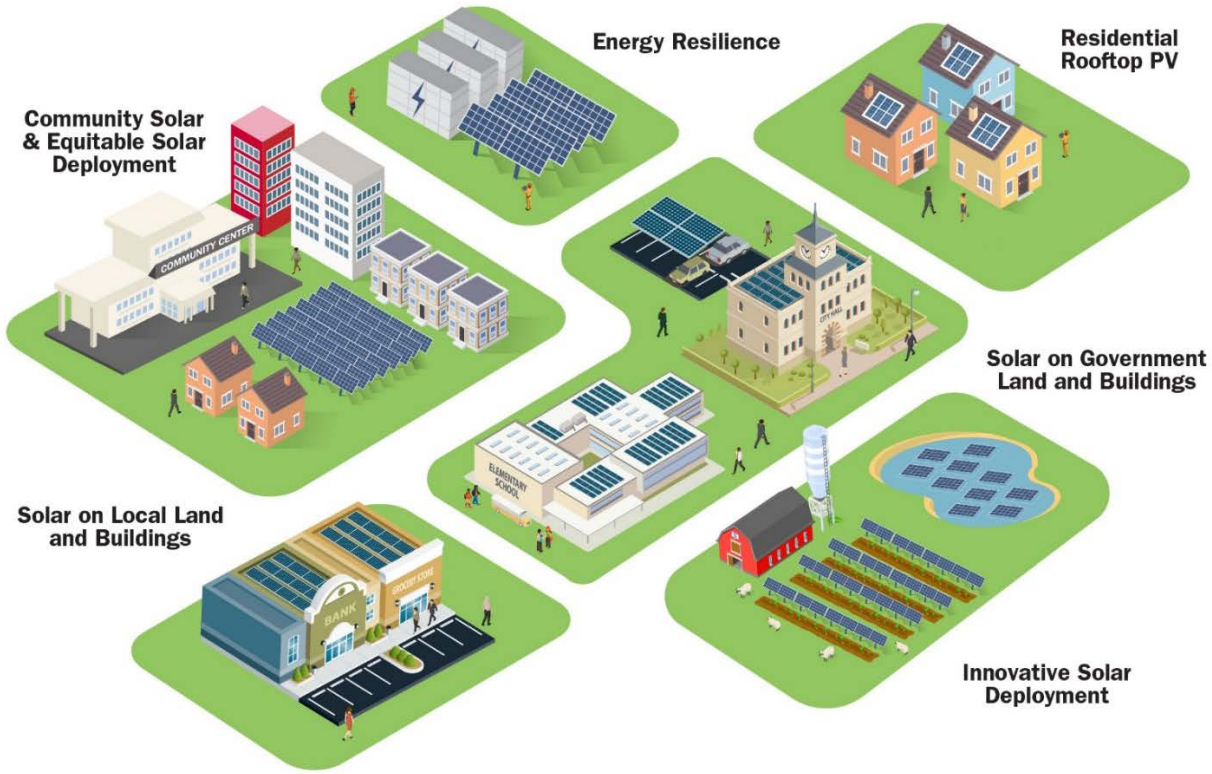

Figure 1. Technologies and topics included in the Solar Power in Your Community guidebook

This guide offers many best practices for overcoming common barriers in today's solar market. Recognizing that there is no single path to solar market development, this guidebook lays out a range of policy and program options. Local government leaders need not undertake all these activities to be successful, but can tailor an approach that fits a community's particular needs and market barriers.

Comments, feedback, suggestions, and successes related to this guidebook are welcome and can be submitted at forms.office.com/g/eCZUJKinEr, via the QR code below, or directly to the lead author, Emily Fekete of the National Renewable Energy Laboratory (NREL), at Emily.Fekete@nrel.gov.

Navigating This Guidebook

Each section of the guidebook is divided into topic areas that are within the jurisdiction of local governments and have been integral to creating and supporting local solar markets. For each section, the guide includes the following subsections:

Introduction and Recommendations: Each topic area begins with an introduction that describes the policy, program, or concept and states its purpose, followed by recommendations and best practices.

Case Studies: Each topic also highlights real-world applications from a wide range of communities that have successfully implemented the policy, program, or concept. Included case studies are highlighted in Figure 2 and a list of the case studies is in Appendix D.

Resources: Each topic lists supplemental resources, including reports, references, and tools that offer more information or guidance on the policy, program, or concept.

Solar Spotlights: Two sections highlight critical equity issues related to solar: one on access for LMI communities (p. 27) and one on racial equity in solar deployment (p. 70).

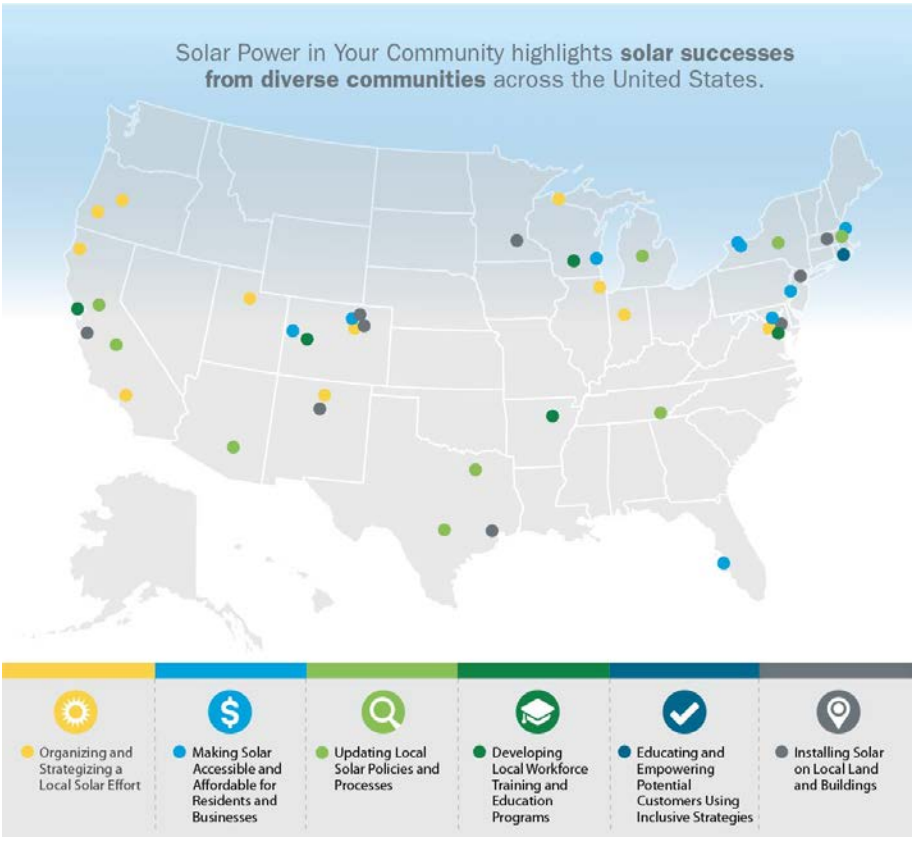

Figure 2. Solar Power in Your Community case studies

1 ORGANIZING AND STRATEGIZING A LOCAL SOLAR EFFORT

The most difficult part of strategically accelerating the adoption of solar energy technologies is getting started. The range of opportunities is vast, and many of the issues are complex. Taking the time to organize and develop a strategic approach will help community leaders make the best choices for their community. This section introduces activities that have proven effective in the early planning stages of designing a local solar energy strategy.

1.1 Create a Solar Advisory Committee or Task Force

Building a sustainable local solar market requires a comprehensive and coordinated effort among many community stakeholders. A good starting point is to create an advisory committee or task force that includes a broad cross section of the community. A comprehensive advisory group helps local governments understand the perspectives of and obtain buy-in from the various market participants involved in solar energy. Establishing limits on the time that members can serve in the group can further promote the inclusion of diverse viewpoint and allow the guidance provided by the advisory group to evolve with the industry and community.

TIP

The following are examples of potential group members:

Solar industry representatives, such as installers, developers, local manufacturers, and relevant labor organizations (see Section 4.3 for more information on unions)

Subject matter experts, such as policy analysts, technical experts, and advocates

Members of local nonprofits, environmental groups, and other community-based organizations (CBOs), or local members of national organizations

Residents from various income levels and communities of color

Utility representatives

Local government budgetary staff or representatives from other organizations with sources of funding

Local government planning and sustainability staff, which may include resilience or emergency managers

Local government infrastructure and maintenance staff

Local city council members, county supervisors, and other government officials and decision makers

Zoning, building, and permitting officials

Homeowners, renters, residential building owners or managers, and multifamily affordable housing (MFAH) owners or managers

Representatives from local businesses, chambers of commerce, financial institutions, and workforce development boards

Representatives from local education and training institutions

Members of existing working groups, such as those focusing on climate change, building energy efficiency, and justice, equity, diversity, and inclusion

Residents who champion solar in the community.

Case Studies

Golden Opportunities for Solar and Sustainability

The City Council of Golden, Colorado, first created a Community Sustainability Advisory Board in 2007. This board includes representatives from environmental nonprofits, the building community, and City Council who have professional expertise in fields such as financial planning, engineering, environmental science, and renewable energy. In 2019, the board helped the city revise existing sustainability goals and set new targets related to energy, water, and waste. Goals include achieving 100% renewable energy for electricity by 2030 and 100% renewable energy for heating by 2050.

In the city's Sustainability Strategic Plan, the top strategy for achieving 100% renewables is an ordinance intended to protect solar access (the ability to get sunlight for an array) and regulate compensation required in the event of solar exposure conflicts such as tree shading. The second strategy is to increase rooftop solar for homes and businesses through an ordinance that requires solar on all new multifamily and commercial projects constructed in Golden. Solar is also featured prominently throughout the rest of the plan. Six resolutions and ordinances related to community solar gardens and reducing solar permit fees have been passed.[3] More than 2 megawatts (MW) of solar have been installed on Golden homes and businesses since 2008. These efforts earned the city a SolSmart Silver designation.

For more information, see the City of Golden's Community Sustainability Advisory Board, Golden's SolSmart designation page, and the 2020 Sustainability Strategic Plan.

Resources

Clean Energy Equity Examples – This resource from the Low-Income Solar Policy Guide is a list of clean energy equity examples at the state and city level, which includes equity advisory, oversight, and working groups.

SolSmart's Toolkit for Local Governments: Stakeholder Engagement – This chapter from the SolSmart Toolkit for Local Governments provides guidance to local government staff on stakeholder engagement.

[3] Community solar is a distributed solar energy deployment model that allows customers to buy or lease part of a larger, off-site shared solar photovoltaic (PV) system. Also known as shared solar or solar gardens.

Energy Transitions Playbook – This resources from DOE includes a stakeholder matrix and stakeholder mapping template to help identify and categorize stakeholders for creating an advisory committee or task force.

Vermont Energy and Climate Action Network: Getting Started – This resource covers the creation and operation of committees focused on renewable energy and climate change solutions.

1.2 Coordinate With Key Organizations

In addition to including members of key organizations on solar advisory committees and task forces, coordinating with these and other relevant organizations can increase the effectiveness, equity, and inclusiveness of any effort, as highlighted below.

State Energy Offices

State energy offices create energy programs and fund projects, which can help local governments pursue solar goals. Resources include technical assistance programs, information on state funding opportunities, and connections with other local governments that have modeled successful solar strategies. DOE's Federal Energy Management Program provides a list of State Energy Offices and Organizations. Illinois is the only state not on this list, but it has an Environmental Protection Agency Office of Energy.

Utilities

It is important to understand the utility rules and incentives that affect solar adoption, such as system size limits, compensation mechanisms, and interconnection processes. In addition, some states are enabling utilities to assist with enrolling customers and implementing consolidated billing for community solar, which can reduce program administrative costs. Local governments can also pursue partnership opportunities and franchise agreements with utilities.

Community-Based Organizations

Community nonprofit organizations focused on renewable energy development can assist local governments by providing resources, identifying local solar advocates and individuals that can represent the communities views, enabling equitable deployment of solar, and helping with other aspects of solar implementation. Connecting with CBOs beyond those that focus on renewable energy is also important for developing an improved understanding of community needs, diversifying the pool of potential solar adopters, and addressing local barriers and equity issues related to solar.

The following suggestions can enhance local government engagement with CBOs:

- Partner with CBOs to provide engagement opportunities while organizing a solar effort.
- Work with CBOs to publicize meetings and consider co-branding a meeting with a CBO to increase participation.

- Co-develop and publish local outreach materials with a CBO.
- Host meetings at faith-based organization locations or other spaces where CBOs convene.

Tribal Communities

Ensuring that local tribal communities are represented in decision-making is essential to identifying and mitigating potential impacts on tribes and their resources and expanding solar access to tribal members. When engaging local tribes, it is important to understand their sovereignty as well as their unique histories and cultures, decision-making authorities, and relationships with government entities. The Tribal Energy Atlas can help identify federally recognized tribal communities and lands. Intertribal organizations, such as the Alaska Federation of Natives, Midwest Tribal Energy Resources Association, Great Lakes Inter-Tribal Council, Inc., and Affiliated Tribes of Northwest Indians, can also be included in solar planning.

Labor Unions

Labor unions involved in solar work (e.g., International Brotherhood of Electrical Workers (IBEW), Laborers' International Union of North America) are usually affiliates of local Building and Construction Trades Councils. These unions and others often provide high-quality training for solar, energy storage, and other renewable energy technologies through their registered apprenticeship programs. Partnerships or agreements between solar employers and the relevant labor unions can help ensure that local solar deployment supports good-quality, career-track jobs and that solar providers have access to a trained and qualified workforce.

Higher Education Institutions

Universities, colleges, and community colleges can be sources of expertise through research and development, published documents, and public outreach in the form of extension work (educational activities for people who are generally not full-time students). They can participate in pilot programs, own or invest in solar systems, and buy solar electricity. They can also provide educational programs in solar construction, installation, and maintenance that contribute to developing the skilled local workforce needed to expand local solar markets. When considering potential institutions for partnerships, communities focusing on equity may consider partnering with Minority Serving Institutions (MSIs) or Historically Black Colleges and Universities (HBCUs). For more information on Solar in Higher Education, see Section 4.2.

Case Studies

Making Energy Work for Rural Oregon

Sustainable Northwest is a nonprofit organization focused on community collaborations for long-term benefits. The organization led a coalition of rural community leaders in 2018–2019 to advance the use of community solar on nonprofit facilities. Team members included Douglas County Smart Energy, Hood River County, and Lake County Resources Initiative. The team partnered with the Oregon Clean Power Cooperative to raise funds to build solar installations on

nonprofit sites, including a rural library and an animal shelter. The cooperative owns the arrays, and the nonprofits benefit from reduced energy rates. The team installed 120 kilowatts (kW) of solar on four nonprofit sites. Bringing together many different stakeholders and leaders helped the project to be successful. The project won the Best Nonprofit Project award in DOE's national Solar in Your Community Challenge.

For more information, visit Solar in Your Community Challenge and Sustainable Northwest.

Resources

Community Outreach and Solar Equity: A Guide for States on Collaborating With Community-Based Organizations – This guide from the Clean Energy States Alliance (CESA) is aimed at state energy agencies that are looking to strengthen relationships with local under-resourced communities or that are beginning to engage in energy justice work. The guide is a collection of best practices, ideas, and principles that provide states with a foundation for building equitable relationships with CBOs and working with them on solar development.

Working Effectively With Tribal Governments – This guide from the state government of Michigan provides information about tribal communities, including an introduction to concepts, federal law, and tips for working more effectively with tribal governments.

1.3 Engage Local Stakeholders in Decision-Making

To increase solar deployment effectively and equitably, it is critical to engage a diversity of local stakeholders—including members of underserved communities—in decision-making using appropriate strategies for gathering public input. Local governments can use such strategies to understand local priorities and inform solar target setting (see Section 1.5), identify contextual issues such as local land use and historical inequities (see Solar Spotlight: Racial Equity in Solar Adoption on page 71), and educate the public about solar (see Section 5).

Appropriate public meeting strategies can include the following:

- Allow multiple opportunities to engage in decision-making.
- Provide advance notice of engagement opportunities and publicize the timeline for future opportunities.
- Publicize meetings in languages used locally.
- Schedule engagement opportunities around work schedules, when more people can attend, and schedule multiple times for critical topics to accommodate different work schedules.
- Offer online and in-person engagement options.
- Consult with residents and businesses to identify comfortable and accessible meeting locations, such as the public library (which can also publicize engagement opportunities).

- Enhance accessibility via free parking, free transportation, compensation for attendance, food, beverages, on-site childcare, and so forth.
- Ensure that in-person meetings are Americans with Disabilities Act accessible. See more on how to Create Accessible Meetings.
- Provide materials in multiple languages for in-person meetings; for online meetings, include closed captioning in recordings and offer transcripts in other languages.
- Partner with CBOs (see Section 1.2).
- Plan engagement opportunities, such as periods for public comments, that are clear but flexible to accommodate feedback.
- Engage rural communities via individual relationships and by leveraging relationships with trusted community organizations.

Beyond in-person and online meetings, various other methods can be used to engage residents and business owners in solar decision-making:

- Informational displays at locations such as libraries, community centers, and schools.
- Local surveys that are accessible via mobile devices.
- Discussions at community group meetings.
- Engagement—such as distribution of surveys, educational materials, and public meeting notices—at local events.
- Focus groups for gathering in-depth views on local perceptions of solar.
- Workshops for educating stakeholders, facilitating discussion, and identifying barriers to solar adoption.
- Solar fact sheets shared at events, online, or both.
- Interactive maps of the solar potential of homes and businesses.
- Websites providing information on local solar programs, policies, and regulations; solar permitting; solar contractors and installers; upcoming events; and so forth.
- Recognition programs to promote awareness of local solar installations.
- School curricula (see Section 4).
- Solar demonstration projects on public buildings with an educational component.
- Games and other interactive activities that illustrate solar issues and opportunities.

For more information on local engagement, see Best Practices for Meaningful Community Engagement and Public Engagement: The Key To Building Inclusive Communities. For more

information on solar-specific local engagement, see the American Planning Association's Solar Community Engagement Strategies for Planners.

Case Studies

Fairfax County Community-Wide Energy and Climate Action Plan

Fairfax County, Virginia, is developing a Community-Wide Energy and Climate Action Plan (CECAP) focused on greenhouse gas reduction. The plan will be developed by a working group that is made up of subject matter experts, business leaders, nonprofits, and community members and will ultimately include up to 70 members. Public meetings and local engagement are included in this plan (available virtually due to COVID-19) and incorporate options such as online surveys available in four languages, comment periods, public access to working group meetings, and opportunities for residents to become "CECAP Community Partners." Notable successes of this strategy include a strong Solarize campaign implemented by the county and a reduction of the residential solar permit fee to $0. Fairfax County has been designated a SolSmart Gold community for the many actions taken to increase solar accessibility and affordability.

For more information, visit Climate Change Planning and Action, Solarize Fairfax County, and Fairfax County's SolSmart designation page.

Solar Salt Lake Partnership

Salt Lake City and Salt Lake County, Utah, faced regulatory, financial, and educational barriers to growing solar energy in 2007. To overcome these barriers, Salt Lake City and Salt Lake County joined with a local nonprofit, Utah Clean Energy, to form the Solar Salt Lake Project. This public-private initiative was successful in increasing local solar deployment, largely due to a focus on local engagement and outreach. The Solar Salt Lake Project engaged with stakeholders, including the local utility, regulators, policymakers, planning and zoning officials, citizens, and businesses, through media campaigns, solar workshops, forums, strategic collaborations, and a solar mapping website. The program used a variety of engagement methods and tools to reach a diverse set of stakeholders and to increase education and awareness. In the first five years of the program rooftop solar PV capacity in the city and county increased nearly 4,000 percent (American Planning Association n.d.). Another success of the program includes updating local interconnection policies to remove burdensome requirements and raise the kilowatt limitation on processes allowing larger projects to be approved with less procedural requirements.

For more information, visit Solar in Action: Salt Lake City, Solar Briefing - Solar Community Engagement Strategies for Planners, and Salt Lake City's SolSmart designation page.

Solar Powering Sunnyside

Planners in Tippecanoe County, Indiana, invited community members to play a board game developed by the American Planning Association, Solar Powering Sunnyside, in which

participants help a fictional town plan for expanded solar power. The exercise is meant to help participants understand tradeoffs and learn about solar energy while facilitating conversation. Through the engagement exercise, the county was able to prioritize solar technologies residents were interested in and update local ordinances based on those priorities.

For more information, visit Solar Powering Sunnyside.

Resources

A Guidebook on Equitable Clean Energy Program Design for Local Governments and Partners – This guide from the Cadmus Group helps local governments design equitable clean energy programs.

Achieving Cooperative Community Equitable Solar Sources (ACCESS) – This project from the National Rural Electric Cooperative Association shares research on how to make solar energy affordable for LMI communities. This page has tools and resources on equitable and affordable solar deployment.

Community Outreach and Solar Equity: A Guide for States on Collaborating With Community-Based Organizations – This guide from CESA is aimed at state energy agencies that are looking to strengthen relationships with local under-resourced communities or that are beginning to engage in energy justice work. The guide is a collection of best practices, ideas, and principles that provide states with a foundation for building equitable relationships with CBOs and working with them on solar development.

National Community Solar Partnership (NCSP) – NCSP is a coalition of community solar stakeholders working to have community solar projects provide 26GW of power and create US$1 billion in bill savings by 2025. Technical assistance is available to members. NCSP also includes partner collaboratives that work together to identify and address common barriers, as well as educational materials.

SolSmart's Toolkit for Local Governments: Stakeholder Engagement – This chapter from the SolSmart Toolkit for Local Governments provides guidance to local government staff on stakeholder engagement.

Working Effectively With Tribal Governments – This guide from the state of Michigan provides information about tribal communities, including an introduction to concepts, federal law, and tips for working more effectively with tribal governments.

1.4 Obtain Technical, Financial, and Personnel Support

Various forms of support are available to local governments when organizing their solar efforts, including technical assistance, funding opportunities, and support from interns and fellows.

Technical Assistance

Technical assistance—or nonfinancial assistance provided by experts—can take the form of information, skills training, technical data, or consulting services, and it can be obtained during any stage of local solar development. Table 1 highlights some opportunities for technical assistance as of 2021. These programs are not on demand and require applications for support. Interested parties should access program websites for more information on availability and application. Regional technical assistance opportunities may also be available.

Table 1. Opportunities for Technical Assistance as of 2021

Technical Assistance	Description	Website
SolSmart Technical Assistance	All cities, counties, and regional organizations are eligible for no-cost technical assistance to meet SolSmart criteria and achieve solar goals.	https://solsmart.org/how-we-help/types-of-assistance/
Energy Transitions Initiative Partnership Project (ETIPP)	DOE national laboratories provide technical assistance to remote, island, and islanded communities to help increase local energy resilience.	https://www.energy.gov/eere/about-energy-transitions-initiative-partnership-project
Directory of State Low- and Moderate-Income Clean Energy Programs	CESA maintains a directory of state clean energy programs, including technical assistance programs, for LMI residents and communities.	https://www.cesa.org/projects/state-energy-strategies-project/directory-of-state-lmi-clean-energy-programs/
DOE Office of Indian Energy Policy and Programs (OIE)	OIE provides federally recognized tribes, tribal energy development organizations, and other organized tribal groups and communities with technical assistance to advance tribal energy projects.	https://www.energy.gov/indianenergy/technical-assistance
National Community Solar Partnership (NCSP)	NCSP is a coalition of community solar stakeholders working to have community solar projects provide 26GW of power and create US$1 billion in bill savings by 2025.	https://www.energy.gov/communitysolar/community-solar
Solar Energy Innovation Network (SEIN)	NREL provides technical assistance to diverse teams of stakeholders to develop and test solutions to real-world challenges associated with solar energy adoption.	https://www.nrel.gov/solar/market-research-analysis/solar-energy-innovation-network.html
Communities LEAP	The DOE Communities LEAP program (Communities: Local Energy Action Program) is a new competitive technical assistance program specifically designed to support low-income, energy-burdened communities across the United States that are also experiencing either direct environmental justice impacts, or direct economic impacts from a shift away from historical reliance on fossil fuels.	https://www.energy.gov/communitiesLEAP/communities-leap

Funding Opportunities

Localized funding opportunities for pursuing solar include state and utility programs. For example, the New York State Energy Research and Development Authority (NYSERDA) provides grants to address barriers to solar installations for LMI households, grants to local

governments that demonstrate leadership in clean energy, funding for training programs, and more. See NYSERDA's Current Funding Opportunities page for more information.

Interns and Fellows

An intern or fellow can be hired to pursue local solar development while developing their own career skills. Interns may be hired at relatively low cost through programs with high schools or colleges. A fellow is an early-career professional who works for a set amount of time, typically longer than a summer internship. Setting a concrete role for interns or fellows helps them achieve realistic goals. For the outcomes and resources an intern or fellow is delivering to be effective, it is important that the work be reviewed and vetted, or otherwise supported, by experienced employees or experts in the space.

Possible roles for an intern or fellow include the following:

- Research local, state, and federal policies that impact solar adoption.
- Research funding and/or technical assistance opportunities and develop applications thereof.
- Develop educational materials for solar tailored to local needs.
- Talk to similar communities about their experiences and lessons learned.
- Develop a stakeholder engagement strategy and manage outreach to stakeholder groups.
- Organize local meetings and plan strategies for successful engagement during these meetings.
- Plan and execute a local survey to develop a baseline on community solar priorities.
- Coordinate a jurisdiction's pursuit of SolSmart designation.

For examples of fellowship programs, see CivicSpark, Climate Corps, Massachusetts Clean Energy Center Clean Energy Internship Program, RAY Fellowship, SolarCorps Fellowship Program, and Clean Energy Innovator Fellowship.

1.5 Establish Solar Installation Targets

Setting solar installation targets helps clarify the role solar energy will play in achieving a community's broader resilience, sustainability, and climate action goals and plans. Setting targets helps create momentum for a solar program with stakeholders working toward common goals. It also guides the strategy for increasing solar installations in a community and enables leaders to track progress against a published goal. Solar installation targets can also aid in attracting the solar industry to bring jobs and economic benefits to a community. Targets can be set in terms of a percentage of electricity use sourced from solar, an amount of installed solar capacity, a number of customers subscribed to a community solar project, a number of LMI households adopting solar, a percentage of community solar dedicated to LMI households, and so forth.

Energy storage capacity can also be taken into consideration when establishing solar installation targets.

Solar target setting should begin with the development of an installation baseline that provides insight into a community's experience with solar energy. A baseline survey can be used to determine the number of installed solar systems, system sizes, system technologies (PV or solar thermal), and sectors (residential, commercial, and industrial; community/shared solar; and large-scale solar). Such data can be gathered from government departments tasked with solar permitting, the local utility, solar installers, the state energy office, and industry associations (e.g., the Solar Energy Industries Association).

After an installation baseline has been developed, it can be used to establish realistic local solar targets. The following recommendations can facilitate effective target setting:

- Identify programs and policies that support or hinder solar deployment at the state, local, and utility levels (see Appendix A).Community SolarConsolidated BillingAppendix A
- Identify potential space available in the community for rooftop and ground-mounted solar installations.
- Understand the local solar market, including the price and availability of solar technologies, tax incentives, subsidies, and the operations of local solar developers and installers.
- Consider current grid electricity costs and the amount of electricity used by different sectors (residential, commercial, industrial).
- Understand community priorities for solar deployment, such as reducing carbon emissions, lowering electricity bills, and improving public health.
- Identify related goals, such as electric vehicle (EV) adoption, charging station deployment, or electrification.
- Involve stakeholders in target setting (see Section 1.3).
- Compare targets with the targets of similar communities.
- Set multiyear targets and short-term milestones, and establish transparent measurement and accountability processes tied to these objectives.
- Celebrate the achievement of milestones with public announcements or events.

For more information, see How To Set Renewable Electricity Goals That Align With Community Priorities from the Great Plains Institute. Table 2 lists tools that can help with solar target setting.

Table 2. Tools To Assist in Solar Target Setting

Tool	Host	Description	Benefits for Target Setting
DeepSolar	Stanford	DeepSolar analyzes satellite imagery to identify locations and sizes of U.S. PV panels.	This tool helps determine the number of local solar installations.
Low-Income Energy Affordability Data (LEAD)	DOE	The Low-Income Energy Affordability Data (LEAD) tool is designed to help states, communities, and other stakeholders create better energy strategies and programs by improving their understanding of low-income housing and energy characteristics.	This tool can be used to reduce energy costs and target energy affordability services and energy savings services to eligible LMI customers in specific areas.
National Solar Radiation Database (NSRDB)	NREL	The National Solar Radiation Database (NSRDB) provides hourly and half-hourly values of meteorological data and the three most common measurements of solar radiation: global horizontal, direct normal, and diffuse horizontal irradiance. This data is used to power several of the models listed above.	The NSRDB provides the data behind many of the powerful models listed here. Local government officials or stakeholders may choose to access this data to reinforce solar planning decisions.
Project Sunroof	Google	Project Sunroof is a solar calculator from Google that displays solar potential and impact across entire geographic areas and can provide solar savings potential for specific locations.	This tool can be used to estimate the solar potential for a local jurisdiction.
PVWatts Calculator	NREL	The PVWatts tool estimates the energy production and cost of energy of grid-connected PV energy systems at any location throughout the world. It allows homeowners, small building owners, installers, and manufacturers to easily develop estimates of the performance of potential PV installations.	This tool can provide estimates of a system's annual and monthly electricity production and an estimate of the value of that electricity for a system on a government building (or at any specific location).
REopt	NREL	The REopt® techno-economic decision support platform is used by NREL researchers to optimize energy systems for buildings, campuses, communities, microgrids, and more. REopt recommends the optimal mix of renewable energy, conventional generation, and energy storage technologies to meet cost savings, resilience, and energy performance goals.	This tool can be utilized by local governments to create optimized systems for local government buildings, ensuring they are meeting energy performance and/or resilience goals.
Solar Demographics Tool	LBNL	The Solar Demographics tool allows users to visualize and download data from the Lawrence Berkeley National Laboratory (LBNL) report, *Income Trends Among U.S. Residential Rooftop Solar Adopters*.	This tool provides information on solar adoption based on income level.
State and Local Planning for Energy (SLOPE)	NREL	The State and Local Planning for Energy (SLOPE) platform delivers jurisdictionally resolved potential and projection data on energy efficiency, renewable energy, and (coming soon) sustainable transportation to enable data-driven state and local energy planning.	This platform makes it easier for state and local governments to consider, compare, or fully capture the value of energy efficiency, renewable energy, and sustainable transportation-related resources.
Tracking the Sun Visualization	LBNL	Tracking the Sun allows users to access data about distributed solar, including installed system prices, customer segmentation, mounting configuration, and more.	This visualization tool helps to establish a local baseline and clarify the status of solar in an area.

Types of Solar

There are four main types of photovoltaic solar deployment which local governments may consider in their planning. The types of solar are differentiated by their size and scale. Understanding the differences between the types of solar deployment can help local governments identify the scale of solar deployment that can best meet community needs. Although each category does not have a standard size, these definitions include the typical size range for each type.

- Residential solar: Also referred to as "rooftop solar", residential solar is a form of distributed energy with solar panels mounted on individual rooftops. Residential solar deployments can range in size from 3 kW–11 kW (Feldman et al. 2021).
- Commercial solar: Commercial solar is a larger form of distributed solar energy that encompasses rooftop and ground-mounted deployment. Commercial solar deployments can range in size from 100 kW–2 MW (Feldman et al. 2021).
- Community solar: Also referred to as "solar gardens" or "shared solar", community solar is another form of distributed energy where customers can buy or lease a portion of an off-site shared solar project. Community solar sites are typically <5 MW in size. See more information on community solar in Section 6.2.
- Utility-scale solar: Utility-scale solar deployments are ground-mounted systems that feed the generated electricity directly into the electric grid. Utility-scale solar deployments can range in size from 5–100 MW (Feldman et al. 2021).

The size estimates included here are not strict boundaries, and state or local laws may define solar deployment sizes differently. This guidebook focuses primarily on residential and community solar. Innovative applications of solar energy, like agrivoltaics or floatovoltaics, fall within these categories depending on the scale at which they are deployed. See Section 6.4 for more information on innovative solar deployment.

Low- and Moderate-Income Targets

Solar targets specific to LMI communities can help ensure more equitable solar deployment at the local level, but will require a clear definition of LMI in order to set goals. LMI-specific targets may also exist at the state level. For example, some states, such as Colorado and Oregon, have an LMI carve-out in their community solar policies that dedicates a certain percentage of community solar subscriptions to LMI households. Section 2.4 describes LMI-targeted financing options.

The following obstacles to LMI solar deployment should be considered when setting LMI-specific targets:

- Upfront installation costs and community solar subscription costs can be prohibitive for LMI households.

- LMI households may have lower credit scores, making solar financing products more difficult to obtain.
- The federal investment tax credit (ITC) and other state and local tax incentives for solar deployment may be unavailable to LMI households because of insufficient tax burdens (see Appendix A).
- LMI households are more likely to live in multifamily housing or rent their homes, and thus have less control over rooftop space and potential solar installations.
- LMI households are more likely to have roofs unsuitable for solar installation because of instability, lack of strength, or age (Garren et al. 2017).
- In rental units, building owners may not have an incentive to install solar when renters pay the electricity bills (see Section 6.3).
- LMI customers who have reduced electricity rates via energy assistance programs may have lower rates than the rates available for solar adopters.
- LMI communities may not be familiar with solar benefits because they have not been targeted for solar investments in the past.
- LMI households are more likely to have seasonal income, move more often, and use less electricity, making on-site solar and subscription agreements more difficult.
- LMI communities have been targeted for predatory offerings in the past, possibly making potential customers more wary of new products.

100% Renewable or Carbon-Free Targets

Some municipalities and states are targeting 100% renewable energy or 100% carbon neutrality by a certain date, often with interim goals along the way.

TIP

The following strategies can increase the contribution of solar to achieving such goals:

- Plan to power some or all municipal operations with solar.
- Adopt policies that enable residents and small businesses to install on-site solar and/or invest in community solar projects.
- Encourage high energy consumers to use roof and parking-lot space for on-site solar through local tax incentives.
- Require solar installations through solar-ready building codes (see Section 3.2).
- Streamline solar permitting and inspections (see Section 3.3).
- Set a subgoal of achieving a certain percentage of rooftop PV technical generation potential (the potential if solar were installed on all suitable rooftop space).
- Work with the local utility to create a supply option from utility-scale PV.

This list is adapted from the Sierra Club's Guidelines for Community Commitments to 100% Renewable Energy. Visit the Sierra Club's interactive map or CESA's Map and Timelines to view what states and communities have committed to 100% clean, renewable energy.

Case Studies

Los Angeles 100% Renewable Energy Study (LA100)

Los Angeles and NREL studied the pathways and costs to achieve a 100% renewable electricity supply in the city by 2045. The study found that Los Angeles has over 13 gigawatts (GW) of solar rooftop technical potential, more than half of which is in the residential sector. The study also showed that the city has 2 GW of technical potential for rooftop solar on multifamily buildings. Overall, the study projected that 2.8–3.9 GW of rooftop solar could be adopted by 2045. Los Angeles can use these projections to help set solar adoption goals within the 100% renewable energy goal.

For more information, see LA100: The Los Angeles Renewable Energy Study Executive Summary, LA100: Chapter 4, Customer-Adopted Rooftop Solar and Storage, the LA100 Website, and Pioneering NREL Analysis Empowers Los Angeles in Its Pursuit of 100% Renewables.

Picuris Pueblo of New Mexico 100% Renewable Goal

Picuris Pueblo, a tribe in New Mexico, is home to about 300 tribal members and encompasses about 17,000 acres of land in an isolated area of the state. The tribe set a goal of achieving 100% renewable energy, and pursued technical assistance from NREL, DOE grants, and financial agreements with Kit Carson Electric Cooperative, which signed a 25-year power-purchase agreement to buy electricity from the tribe's 1-MW PV array. This arrangement offsets 100% of the costs of energy used by tribal buildings and residences on the tribal trust lands, and it offsets 26% of the daily energy needs of the Kit Carson Electric Cooperative.

For more information, see Final Report Pueblo of Picuris.

Resources

Advice for States on 100% Clean Energy Planning – This resource was developed by CESA to assist states (and other entities) that have 100% clean energy goals by providing knowledge-sharing activities and analysis so that together they can address program challenges and opportunities.

Cities Renewables Accelerator – The American Cities Climate Challenge is a program from Bloomberg Philanthropies to help cities meet carbon-reduction goals. The Cities Renewables Accelerator, which is part of this program, supports cities with procurement. This program also offers technical assistance on economic inclusion to leverage procurement and other activities to support good local jobs.

CELICA Toolkit: Clean Energy Solutions for Low-Income Communities – This toolkit from DOE's Better Buildings Initiative provides tools, resources, and models for developing low-income energy efficiency and renewable energy programs.

Energy Equity for Renters – This initiative from the American Council for an Energy-Efficient Economy (ACEEE) offers many resources, including a guide for local governments, energy burden research, building performance standards, and more.

Equitable Clean Energy Planning – This series of webinars from the World Resources Institute guides local government staff through equity-centered, scenario-based planning for community-level energy policy.

Guidelines for Community Commitments to 100% Renewable Energy – This document from the Sierra Club provides guidelines for creating an equitable and just transition to 100% clean, renewable energy, and includes options for integrating solar into these goals.

How To Set Renewable Electricity Goals That Align With Community Priorities – This article from the Great Plains Institute discusses how a community can set electricity goals. It has a solar calculator tool to help communities set rooftop solar goals based on available resources.

Local Government Project Portal: Goal-Setting Guidance – This guide from the U.S. Environmental Protection Agency (EPA) provides information on why and how to set a renewable electricity goal and the considerations that should be taken into account. There is also a worksheet for users with actionable steps.

Local Government Strategies for 100% Clean Energy – This webinar from SolSmart provides an overview for setting clean energy goals, including considerations related to COVID-19.

Low- and Moderate-Income Solar Policy Basics – This web page from NREL gives an overview of LMI solar, including barriers to LMI solar uptake, financing mechanisms, and information on community solar, as well as providing additional resources.

Low-Income Energy Affordability Data (LEAD) Tool – This DOE tool provides estimated low-income household energy data at state and local levels. Data include energy burdens, housing units, and income levels.

Low-Income Solar Policy Guide – This guide—developed by GRID Alternatives, Vote Solar, and the Center for Social Inclusion—summarizes barriers to low-income solar and provides information on successful programs, policy tools, and models.

Map and Timelines of 100% Clean Energy States – This map from CESA tracks states' 100% clean energy commitments and timelines.

Ready for 100% Interactive Map – This map, provided by the Sierra Club, details which states and communities have set 100% renewable energy or 100% carbon-free goals.

Shared Accountability Framework: For Community Implementation of 100% Clean Energy Goals – This tool for evaluation from the Sierra Club helps leaders prioritize equity and justice

while evaluating a community's process toward the transition to 100% clean energy. The Companion to the Shared Accountability Framework can help jurisdictions use the framework effectively.

Solar With Justice: Strategies for Powering Up Under-Resourced Communities and Growing an Inclusive Solar Market – This guide from CESA provides recommendations for how to accelerate solar implementation in under-resourced communities.

Tracking the Sun – This report and interactive data visualizations from LBNL summarizes installed prices and other trends among grid-connected distributed PV systems in the United States.

1.6 Include Solar in Resilience Planning

Resilience is the ability to anticipate, prepare for, and adapt to changing conditions, and to withstand, respond to, and recover rapidly from disruptive events (Hotchkiss and Dane 2019). Energy-sector resilience and energy efficiency may be included in local planning, and solar energy can play a role in resilience in conjunction with energy storage, microgrids, and smart grids—if supported by appropriate system designs, siting, and policies. The potential resilience benefits of such approaches include reducing vulnerability to electricity disruptions by diversifying the generation mix, reducing water use,[4] and reducing electricity lost during long-distance transmission and distribution. Solar and solar plus storage can also provide a foundation for microgrids, providing local power when the main grid is disrupted.

Communities can include resilience in their comprehensive energy plans, developing a standalone energy resilience plan, and by evaluating plans already in place (e.g., hazard mitigation plans) to identify opportunities to increase resilience. Energy-sector resilience goals can include preventing or minimizing damage to mitigate disruptive events, diversifying energy sources, enabling continuous energy system operation, accelerating system recovery after a disruption, and lowering energy bills during normal conditions.

These goals should take into account LMI communities as analyses shows that low-income communities are subject to worse national disaster effects based on their location (Hallegatte et al. 2016; Ross 2013; Lee 2018). Resilience benefits for LMI communities include more predictable costs and ensure everyone – including underserved populations – have access to power after a disaster. In addition, more affordable, predictable clean energy can reduce energy burdens and result in economic and social resilience by allowing LMI customers to reallocate energy spending to other essential spending categories.

[4] Generation technologies that rely on water, such as fossil fuel power plants, are vulnerable to drought and other climate events. Technologies that do not rely on water, such as solar, can reduce uncertainty in power generation.

Solar Plus Storage

Pairing PV with energy storage enables unused solar energy generated during the day to be used when the sun is not shining, providing power more continually during a grid disruption and thus increasing the resilience of the local energy system. The falling prices of lithium-ion batteries are helping make this type of system more economically feasible. However, some communities may have ordinances in place which may make installing the system cost prohibitive such as requiring metal casings, sprinkler systems, or other accompanying components with the system. Communities may consider reviewing local ordinances to ensure they are not prohibitive.

TIP

The following are additional benefits of solar plus storage:

- Electricity prices are smoothed by storing solar energy when it is cheap (daylight hours) and using it when electricity prices are higher (evening hours).
- Curtailment is reduced because the storage system can store excess renewable energy that otherwise could not be used.
- Increased energy demand during the evening, when standalone solar generation declines, can be managed more effectively.
- Black start capability is the ability of generation to restart parts of the power system to recover from a blackout.

The Energy Storage Integration Council's Energy Storage Implementation Guide is helpful for understanding the process of adding local energy storage capabilities.

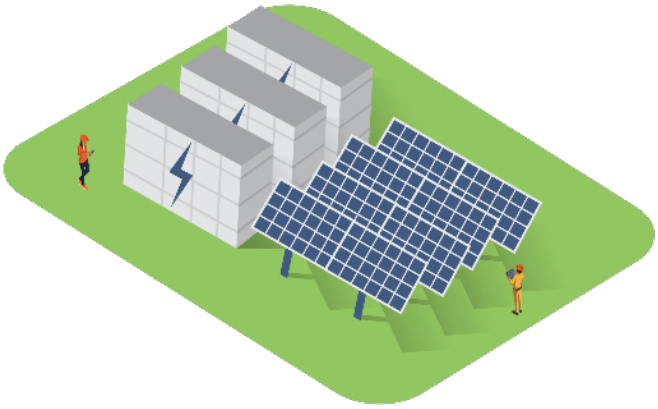

Figure 3. Solar plus storage

Microgrids

A microgrid can be defined as an interconnected group of loads and distributed energy resources acting as a single controllable grid entity, with the ability to connect and disconnect from the grid to operate in grid-connected or island mode (NREL 2021b). Microgrids with solar plus storage can enhance local energy resilience if designed to provide power during a grid outage. Learn more from the Clean Coalition's Community Microgrid Initiative and Sandia National Laboratories' Microgrid Design Toolkit.

Smart Grids

As illustrated in Figure 4, the smart grid concept combines information, sensing, control, and energy technologies to produce an integrated electric power system (Speer et al. 2015). Smart grid technologies include smart meters and sensors, integrated storage, EV charging stations, smart appliances, advanced building automation and control systems, and two-way communications integrated into technologies and appliances. Smart grids have the potential to enable high levels of renewable energy deployment, optimize transmission, distribution use, and demand-side management, and quickly identify and isolate outages for faster system recovery.

Resilience planning should consider whether local utilities have smart grid programs, such as advanced metering infrastructure, EV charging infrastructure incentives, rebates for smart thermostats and other smart appliances, or an online "marketplace" to help connect users with third-party vendors for these services and technologies. However, smart grid programs may result in inequitable access if not addressed, primarily because the online "marketplace" may be adopted disproportionately in wealthier areas.

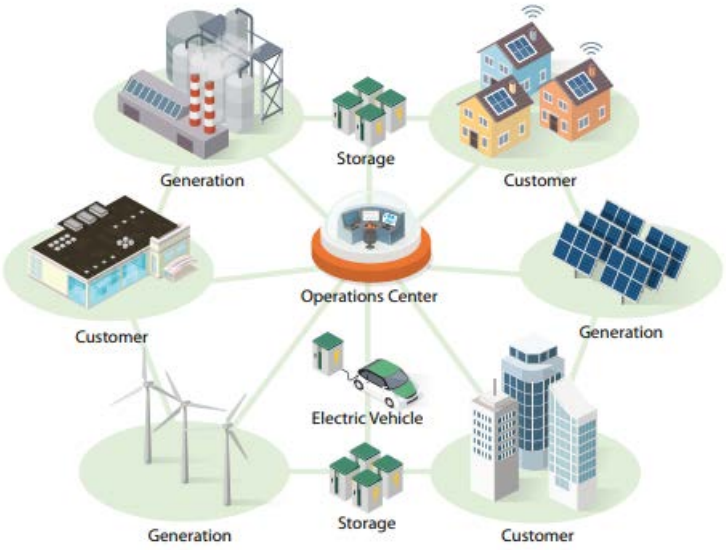

Figure 4. Conceptual model of a smart grid

(Beshilas and Gokhale-Welch, 2020)

Resilience Funding

TIP

Funding for resilience projects is evolving rapidly. Examples of funding opportunities include the following:

- The federal government offers many opportunities; see Federal Financial Assistance Programs for Resilience Activities.
- The Kresge Foundation and the Clean Energy Group seek to support the development of resilient energy systems through loan guarantees, capacity building, and technical assistance; see the Financing Resilient Power Initiative.

- Municipal utilities may offer programs to encourage actions that increase energy resilience.
- Local community choice aggregation (CCA) entities may offer incentive programs; see CCA Resilience Initiatives for examples from California in 2020.

For additional resilience funding opportunities see the Federal Funding Opportunities for Pre- and Post-Disaster Resilience Guidebook.

Energy Efficiency

Increasing the energy efficiency of a facility means that less power is needed for operations. Reducing a facility's power load is a cost-effective strategy for optimizing PV systems and increasing resiliency benefits. Reducing power loads further reduces the costs of generation and grid investments to service that load, and these reduced costs may be passed through to customers depending on the energy market.

Major building energy loads usually include heating, ventilating, and air conditioning (HVAC) systems; lighting; and appliances. On their own, strategically deployed building energy conservation measures (ECMs), i.e., the upgrades, retrofits, repairs and replacements that businesses can implement to become more energy efficient, can lower utility bills, reduce maintenance costs, and increase occupant comfort. Conducting a building energy assessment or audit can help determine which ECMs will be most cost-effective. As overall building efficiency increases, the sizing of some building systems and components, including mechanical systems, solar panels, and even the amount of backup power required to power critical loads in the event of a grid outage, can be reduced, further driving down costs.

Pairing PV with specific ECMs can significantly improve project economics. A recent study found that when sizing an on-site solar plus storage system, three common efficiency measures—solid-state lighting, non-vapor compression air conditioning, and HVAC controls—can reduce annual energy costs by 24%–29%. Furthermore, this approach lowers capital costs and shortens the investment payback period by 24%–28% compared to a design incorporating only solar and battery storage. Facilities can also operate on backup power for longer periods of time if the building is energy efficient—an especially important consideration for spaces serving as community shelters (Deforest et al. 2020; Saslovich 2020).

Case Studies

Bad River Band of the Lake Superior Tribe of Chippewa Indians Microgrid Project

The Bad River Band of the Lake Superior Tribe of Chippewa Indians in northern Wisconsin built the Ishkonige Nawadide Solar Microgrid project after experiencing severe flooding that caused long power outages at critical facilities. The microgrid is designed to withstand future power outages from natural disasters. The system pairs a 500-kW solar array with a 1-megawatt-hour (MWh) battery storage system, powering the tribe's health and wellness center, wastewater treatment plant, and administration building. The systems at the health and wellness center and

wastewater treatment plant will produce enough electricity to offset the facilities' entire loads. The project was supported by grant funding from DOE's OIE.

For more information, visit Common Ground, New Microgrid Is a Symbol of Resilience for Bad River Band, and Long Range Energy Planning Report.

EV Charging, Microgrid, and Resilience in Blue Lake Rancheria

Blue Lake Rancheria is a federally recognized tribe in California, located 300 miles north of San Francisco. The area is at high risk for earthquakes and resulting power loss. Starting in 2013, the tribe started converting the government vehicle fleet to EVs and installing charging stations. The EV infrastructure is supported by the tribe's microgrid, which integrates a 420-kW solar array, a 55-kW battery storage system, control systems, and a 1-MW backup diesel generator. The microgrid can operate with the main utility grid or as an islanded system. The tribe was recognized by the Federal Emergency Management Agency (FEMA) in 2017, earning the Whole Community Preparedness Award for its efforts to address emergency preparedness challenges. The community also serves as an American Red Cross emergency evacuation site.

For more information, see Blue Lake Rancheria Microgrid, Blue Lake Rancheria Receives FEMA's 2017 Whole Community Preparedness Award, Blue Lake Rancheria Transportation.

Bronzeville Microgrid Project

Bronzeville is a neighborhood in Chicago's South Side. Commonwealth Edison (ComEd), the neighborhood's utility, built a microgrid that includes 750 kW of solar and a 500-kW storage system. The system can run continuously for 4 hours in the event of an outage. It is designed to serve 10 critical facilities and connect to a microgrid at the Illinois Institute of Technology. The solar installations are in the Dearborn Homes Community, a public housing project composed of 16 high-rise buildings that is part of the Chicago Housing Authority. The installation serves more than 600 families. LMI residents, like those residing in the Dearborn Homes Community, are more vulnerable during power outages. The project was supported by incentives from the Illinois Future Energy Jobs Act and a DOE grant.

For more information, visit ComEd Gets $4 Million To Build Microgrid in Bronzeville and Solar Housing Linked to Bronzeville Microgrid Provides Social Justice, Technology Research.

Resources

BETTER: Building Efficiency Targeting Tool for Energy Retrofits – BETTER is a software toolkit developed in partnership with DOE and LBNL that enables building operators to identify the most cost-saving energy efficiency measures in buildings and portfolios using readily available building and energy data.

Better Buildings Solution Center – Through the Better Buildings Initiative, DOE partners with leaders in the public and private sectors to make the nation's homes, commercial buildings, and industrial plants more energy-efficient. Better Buildings accelerates investment and facilitates sharing of successful best practices.

Energy Efficiency and Distributed Generation for Resilience: Withstanding Grid Outages for Less – This DOE report describes how energy efficiency can be integrated into planning and includes real-world examples.

Energy Resilience in the Public Sector – This landing page from DOE offers resources and tools for state and local governments on energy and resilience.

Energy Storage Implementation Guide – This guide from the Energy Storage Integration Council covers the complete life cycle of an energy storage project.

Energy Transitions Playbook – This guidebook from DOE's Energy Transitions Initiative provides a seven-phase process for a community-driven transition to a resilient, clean energy system. The Playbook includes worksheets, templates, and case studies to assist communities with planning at any phase

How Distributed Energy Resources Can Improve Resilience in Public Buildings – This DOE report provides three case studies about distributed energy resources in public buildings, as well as a step-by-step guide for how to conduct analysis using two publicly available tools, REopt Lite and the Distributed Energy Resources Customer Adoption Model (DER-CAM).

Microgrids for Resiliency – This report from DOE and NREL discusses the value that microgrids can provide to utilities and customers.

Owning the Benefits of Solar + Storage – This report from the Clean Energy Group describes ownership and financing models for solar plus storage in affordable housing and community facilities.

Power Sector Resilience Planning Guidebook: A Self-Guided Reference for Practitioners – This guidebook from the United States Agency for International Development (USAID) and NREL introduces decision makers to the concepts and steps involved in power sector resilience planning.

Resilience Roadmap: A Collaborative Approach to Multi-Jurisdictional Planning – This step-by-step process from NREL offers guidance for a multi-jurisdictional approach to resilience planning.

Resilient Power Project Map – This map from the Clean Energy Group tracks resilient energy projects in the United States.

Resilient Power Project Toolkit – This toolkit from the Clean Energy Group provides information and resources to help gain a better understanding of resilient power systems and how to approach the planning and development of a resilient power installation.

Resources To Support Initiatives for Low-to-Moderate Income Communities (Part 1) – This webinar from SolSmart is a resource for local governments to understand how to expand solar and energy efficiency deployment in LMI communities. The second webinar in this series provides examples of projects.

State and Local Planning for Energy (SLOPE) Platform – The SLOPE platform delivers jurisdictionally resolved potential and projection data on energy efficiency, renewable energy, and (coming soon) sustainable transportation to enable data-driven state and local energy planning.

Smart Grids in Emerging Markets—Private Sector Perspectives – This fact sheet from USAID and NREL provides an introduction to smart grids, the benefits that smart grids can provide to the grid and to consumers, and policy and technical support considerations that could improve private sector investment in smart grids.

Solar-Plus-Storage 101 – This DOE guide provides a basic overview of solar-plus-storage projects, including information on the technology and associated costs.

Solar PV Emergency and Resilience Planning – This fact sheet from SolSmart discusses the role that solar can play in risk management, response, and recovery from natural disasters.

SolSmart's Toolkit for Local Governments: Resiliency – This section of SolSmart's Toolkit for Local Governments explains how solar-plus-storage systems work and provides guidelines for communities on how to foster the development of this technology as well as successful examples at the local level.

The Role of Smart Grids in Integrating Renewable Energy – This report from NREL discusses the role that smart grids can play in integrating renewable energy into a system, and discusses smart grid technology, policy, and regulation from the perspective of a decision maker.

Understanding Solar + Storage – This report from the Clean Energy Group answers frequently asked questions about solar PV and battery storage.

Will Solar Panels Help When the Power Goes Out?: Planning for PV Resilience – This report from NREL discusses how solar can contribute to resilience with careful design and planning.

Solar Spotlight: Ensuring LMI Inclusion in Solar Efforts

Not all communities have benefited equally from the uptake in solar deployment over the past decade. LMI households, or those earning 80% or less of the area median income (AMI), represent 43% of all U.S. households and account for 42% of residential rooftop potential (Sigrin and Mooney 2018).[5] However, as of 2018, LMI households only represented 15% of residential solar adopters (Barbose et al. 2020).[6] At the same time, LMI communities typically have substantially larger energy burdens than their high-income counterparts, meaning a larger proportion of their income goes toward their energy bill. The median energy burden for low-income households is 8.1%, which is more than three times that of non-low-income households at 2.3% (Drehobl et al. 2020). Other barriers such as insufficient tax burdens can also exclude LMI households from tax credit incentives like the federal investment tax credit for solar (Heeter et al. 2021c).

Solar energy technologies can be used in combination with energy efficiency and other programs to reduce the energy burden of low-income customers. Solar can also offer additional benefits, such as, reduced need for bill assistance, reduced utility shutoffs, and local job opportunities. Numerus states have implemented programs and policies to address the disparity in solar adoption to date, and local governments have the opportunity to implement their own programs on the local level.

Local LMI solar programs may include strategies to improve energy equity and access to solar such as:

- Specific LMI carve-outs for existing solar programs
- Creating an LMI-specific community solar program, which may be especially beneficial to renters or those without suitable roof space (see Section 6.2)
- Solar on multifamily homes, which can be implemented through local housing authorities or mandated for privately owned multifamily housing (see Section 6.3)
- Loans, grants, rebates, and overall cost reductions for LMI solar adoption (see Sections 1.5 and 2.4)
- Create a Solarize campaign that offers specific benefits or discounts to LMI participants (see Section 2.3)

[5] Inclusive of multifamily and renter-occupied residences.
[6] This study also defines LMI households as those earning 80% or less of their respective AMI.

- Partner with the local utility or state Public Utility Commission on LMI solar programming.

Over the next 10 years, hundreds of GW of solar is projected to be installed nationwide (Davis et al. 2021), and local governments have a large role to play in ensuring that this future deployment is equitable and inclusive of LMI communities.

Resources

Affordable and Accessible Solar for All: Barriers, Solutions, and On-Site Adoption Potential – This NREL report reviews the market and regulatory barriers to low-income solar access and affordability, and summarizes current solutions to those challenges.

Directory of State Low- and Moderate-Income Clean Energy Programs – This directory from CESA describes state clean energy programs for LMI residents and communities.

EJSCREEN: Environmental Justice Screening and Mapping Tool – This tool from the EPA is an environmental justice mapping and screening tool that provides EPA with a nationally consistent dataset and approach for combining environmental and demographic indicators.

Greenlink Equity Map (GEM) – GEM is an online map to help users visualize equity-related issues. It includes data on income, energy burden, water burden, internet access, and more.

Low-Income Energy Affordability Data (LEAD) Tool – This tool from DOE provides estimated low-income household energy data at state and local levels. Data include energy burdens, housing units, and income levels.

Unlocking Solar for Low- and Moderate-Income Residents: A Matrix of Financing Options by Resident, Provider, and Housing Type – This NREL report identifies the most promising strategies policymakers might consider using to finance PV for LMI customers across three housing types: single-family, multifamily, and manufactured housing.

2 MAKING SOLAR ACCESSIBLE AND AFFORDABLE FOR RESIDENTS AND BUSINESSES

After setting solar targets, local decision makers need to understand ways to achieve those targets. This section covers solar products, solar purchasing and procurement mechanisms, the cost of solar, as well as solar financing and incentives for all households and for LMI households specifically.

2.1 Solar Products

Electricity customers have a variety of methods in purchasing solar; however, these methods differ in what is being purchased. Solar energy production results in two products: electricity, which is used to power things; and the renewable energy certificate (REC) to indicate the electricity was produced using a renewable source. Both products have value in the marketplace and can be sold separately or bundled together. Additionally, solar electricity can either be produced in the location it is generally consumed to meet on-site energy demand (on-site solar); or it can be purchased from a solar system located off-site of energy demand (off-site solar), in which case the energy or REC is credited toward a customer. Both on-site and off-site have advantages and disadvantages, which are discussed below.

On-Site Solar

Procuring on-site renewable energy offers several advantages compared to off-site procurement. Entities can leverage underutilized assets, such as rooftops and unused land, for economic gain. Energy produced on-site also offers the benefit of being closer to the energy load than energy procured off-site and does not necessarily need transmission and distribution infrastructure. Energy use can also be optimized to increase the economic benefits on-site in a way that cannot necessarily be done with energy produced off-site (e.g., use more energy when the sun is shining or store energy in a battery for later use on-site). However, the ability to use on-site renewable energy is highly dependent on resource availability, available land or roof space, and government regulations. It many instances it would be impossible to generate all of a customer's electricity needs on-site.

While on-site solar electricity is almost always produced for the benefit of local energy needs, the RECs may or may not be included, depending on how solar is purchased.

Figure 5. On-site solar

Off-Site Solar

Off-site procurement of energy avoids potential solar siting, interconnection, or other barriers present on customers' land and buildings. Off-site procurement also offers other potential advantages, including (1) better matching of the amount of energy needed with the amount of energy produced by renewable energy assets; (2) the ability to take advantage of efficiencies by contracting with one or more off-site renewable energy facilities; (3) the ability to diversify renewable energy procurement, potentially sourcing energy that is complimentary (e.g., wind and solar). Additionally, customers can choose whether to procure solar electricity, RECs, or a bundled project.

Because on- and off-site solar differ in many characteristics, it is important to make sure to choose the right product to achieving specific local goals. The various purchasing options for on-site and off-site solar often differ as well, as discussed below.

2.2 Solar Purchasing Mechanisms

Direct Purchase of Solar Energy System

Customers can purchase solar generation assets, either as an upfront cash purchase or a loan, where the system is paid for over time. There are often economic benefits to directly purchasing a PV asset, for example the ability to claim tax credits. However, owners take on the liability of long-term asset ownership, including the value risk in an asset sale. Additionally, solar energy system owners also need sufficient tax capacity (i.e., pay enough in taxes) to utilize the tax benefits of owning solar.[7] In most cases, customers or business directly purchase a system when it is on-site; however, there are instances of off-site direct ownership with electric utility involvement.

[7] The federal government offers an investment tax credit, for homeowners and businesses purchasing a PV system, currently worth 26% of the cost of the system. Businesses can also deduct all ITC-eligible property costs over an accelerated 5-year depreciation schedule, thereby reducing their taxable income.

Third-Party Ownership of On-Site Solar

An alternative financing option to asset ownership is third-party ownership, available in many states, which allows customers to access solar through a PPA or a lease. Under a solar PPA or lease, a third-party developer builds, owns, operates, and maintains a solar array while a customer hosts the system on their property. A PPA or lease enables a customer to receive renewable electricity at a predictable price without upfront costs. Under a PPA, a customer signs a contract to pay a third party a specific rate for the electricity generated for a defined period of time. A lease allows a customer to pay a monthly rate for use of the PV system, also for a defined period of time. In both cases, the third-party owner benefits from any federal and state tax incentives, and the sale of electricity and RECs (which may or may not be included in the contract to the host customer). Third-party operator financing options can be particularly attractive for LMI, nonprofit, and government customers who do not have the ability to take advantage of the tax benefits of owning a solar system; however, due to tax code restrictions, leases can be problematic for nonprofit and government customers.[8]

For more information about third-party financing, see SolSmart's Toolkit for Local Governments web page on Federal and State Context, the Low-Income Solar Policy Guide, and the Database of State Incentives for Renewables and Efficiency's (DSIRE's) Third-Party Solar PV Power Purchase Agreements Map.

Off-Site Procurement Through VNEM and Green Tariffs

Similar to on-site third-party ownership, customers can procure off-site PPAs for solar through the use of virtual net energy metering (VNEM, see Appendix A) or directly through the electric service provider (Green Tariffs).[9] In these instances, solar electricity generation is credited directly on a customer's utility bill. These programs require utility participation, and therefore may not be available in every location. However, some states have mandated that utilities offer VNEM. If a customer is large enough, they may purchase all of the electricity generated by the off-site solar array; however, for most residential and commercial customers, this is not feasible. In these instances, community solar projects, a distributed solar energy deployment model that allows customers to buy or lease part of a larger, off-site shared solar PV system through a subscription and receive benefits on utility bills, may be an option. See Section 6.2 for more information on community solar.

Community Choice Aggregation

Community choice aggregation (CCA), or municipal aggregation, programs allow local governments in states with CCA-enabling legislation to procure power on behalf of community members from an alternative supplier while using the transmission and distribution services of

[8] Leases are problematic for nonprofits and government entities because the tax code prevents PV system owners from taking the ITC if they are leasing the system to an entity that is not eligible to take the ITC themselves. This is not a problem in states that allow PPAs, as the third-party would have the ability to offer a PPA instead of a lease; however, in some states PPAs are not allowed because only regulated utilities are permitting to sell electricity.
[9] In some instances, off-site solar assets are owned by the customer.

their existing utility provider. CCA is currently enabled in California, Illinois, Ohio, Massachusetts, New Jersey, New York, and Rhode Island. Other states are implementing or studying CCA. All homes, businesses, and municipal sites may be eligible to participate in CCA, but participation is voluntary. Programs can be opt-in or opt-out. The only change with CCA for the electricity customer is the source and price of electricity generation; the same delivery and maintenance services stay in place. CCA allows communities to exercise more control over electricity prices and electricity sourcing.

Virtual PPA

Companies do not need to go through regulated electric utilities to procure off-site renewable energy as long as projects have the ability to sell electricity into a wholesale electricity market.[10] Corporations and project developers utilize wholesale markets by entering into a virtual PPA (otherwise known as a contract of differences, or a financial PPA). As of this writing, virtual PPAs are the most widely used form of off-site corporate renewable energy procurement in the United States. Instead of the developer delivering the power to the customer, like in a traditional PPA, the electricity is sold into the wholesale market. The company and developer agree to exchange the difference between the price at which the energy is sold into the marketplace and the set contract price (or the virtual PPA rate). If energy is sold into the wholesale market at a rate higher than the PPA price, the developer pays the company the difference in value; if on the other hand, the electricity receives a lower price in the marketplace, the company pays the developer the difference in value. At the same time, the corporation purchases energy from its local utility (or utilities), ideally in the same power market. Figure 6Figure 8 below summarizes these various transactions.

[10] Wholesale markets are responsible for serving two-thirds of the United States' electricity load (FERC 2016).

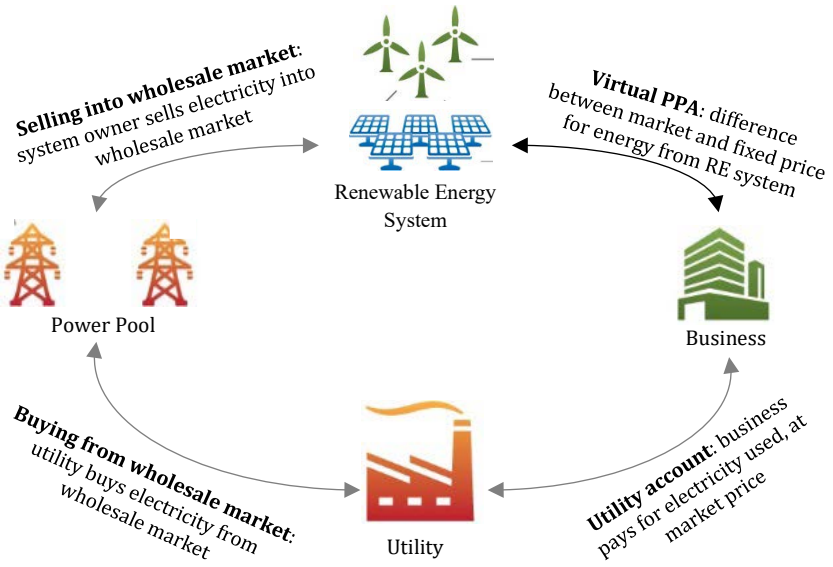

Figure 6. Summary of virtual PPA transactions

In executing a virtual PPA, both the developer and the business are hedged against the electricity market. No matter how much money the developer receives from the electricity sold in the marketplace, they will net the agreed-upon fixed price through the contract of differences. The business is also hedged at that rate because the electricity it purchases from its service provider should be inversely correlated to money it owes or may receive from the developer. If the wholesale rate a project receives is below the fixed price of the PPA, the company will have to pay the developer the difference; however, the company also will pay less to the utility for the energy it received. If the wholesale price of energy is higher than the fixed price in the contract of differences, a company's utility bill is likely to be higher, but it will also receive payments from the developer.

Renewable Energy Certificates

A REC represents the generation of 1 MWh of electricity from a renewable energy source. A solar REC (SREC) represents 1 MWh of electricity from solar generation. The owner of a solar installation may keep and retrieve the credits or sell them to the market if allowed in their state. As of 2020, states with SREC markets included California, Connecticut, Delaware, Illinois, Massachusetts, Maryland, New Jersey, North Carolina, Ohio, and Pennsylvania, plus the District of Columbia, though many other states participate in REC markets without a carve-out for solar (SolSmart 2021). RECs make renewable electricity available to all consumers on the grid, no matter the location of the generator or the consumer. Consumers can purchase RECs from any provider, not just their local utility. By purchasing RECs, the environmental benefits of renewable energy generation can be claimed without impacting actual electricity purchase and delivery. When a REC is sold, the generator can no longer claim these environmental benefits. Read more about RECS and SRECs in Appendix A.

Case Studies

Solar Lease Agreements for City of Boulder Facilities

In 2019, the Boulder City Council authorized lease agreements with Unico Solar Investors, adding 2.75 MW of solar capacity to city properties, including the water treatment plant, fire stations, and parking garages. Boulder will lease the installation sites to Unico Solar Investors and purchase the output of the systems through PPAs. Under this agreement, Unico can take advantage of the federal tax benefits that are unavailable to the city, and Boulder can pursue its renewable energy goals without needing upfront capital.

For more information, visit Boulder's Generation Solar website.

Swampscott Community Power

The Town of Swampscott, Massachusetts, created Swampscott Community Power, a CCA program providing residents and businesses with clean power and predictable electricity rates. Program prices are fixed, whereas the utility changes prices two to four times per year. The program has saved customers over $600,000 on electricity costs since 2016. The program offers three choices to consumers:

- Standard Green Option: the default option, offering 100% renewable electricity.
- New England Green: 100% renewable electricity from projects in New England.
- Basic: meets minimum state requirements for renewable energy (18% in 2021).

For more information, visit Swampscott Community Power.

Opt-Out Community Solar via CCA in New York

In 2020, two New York municipalities, the Villages of Brockport and Lima, entered into a tri-party agreement with Joule and Generate Capital to provide community solar to residents on an opt out basis. The two municipalities signed a community-level tri-party agreement on behalf of their residents and small businesses, enabling eligible account holders to be automatically enrolled in the program and receive credits on their electricity bill. The opt-out community solar program is the first of its kind and will be rolled out to 3,800+ households across the two upstate New York municipalities. Both low- and high-income households have access to the benefits offered by the program, including a guaranteed 10% savings via solar credits, on equal terms.

For more information, visit Groundbreaking Opt-Out Community Solar Program in Brockport and Lima, NY Moves Toward Launch as the Villages Select Solar Provider.

Resources

Community Choice Aggregation Explained in Less Than 5 Minutes – This primer from Solstice discusses the pros and cons of CCA and the relationship between CCA and community solar.

Community Choice Aggregation: Challenges, Opportunities, and Impacts on Renewable Energy Markets – This report from NREL summarizes the status of CCA in the United States, impacts of CCA on renewable energy markets, and challenges.

Explanation of Certain Key Terms in the PPA – This interactive tool from NREL shows a mock PPA and provides definitions for terms within it.

How Local Governments Can Buy Renewable Energy and Support Market Development – This webinar from SolSmart covers strategies that local governments can consider to procure renewable energy. It covers the impacts of the regulatory landscape.

Non-Power Purchase Agreement Options for Financing Solar Deployment at Universities – This fact sheet from NREL discusses financing models and funding mechanisms for solar procurement, with a focus on non-PPA financing models. The fact sheet focuses on universities, but the lessons can be applied more broadly.

Power Purchase Agreement Checklist for State and Local Governments – This fact sheet from NREL provides guidance on PPAs for local and state government entities.

School and Municipal Solar – This page from the Vermont Energy and Climate Action Network provides guides, templates, and case studies for schools and municipalities pursuing solar.

Solar Project Development Pathway & Resources – This web page by the U.S. Environmental Protection Agency describes seven steps for solar project development by local governments. It provides links to videos, guides, templates, reports and case studies to assist in the process at each step.

Solar PV on Municipal Buildings: A Guide to Feasibility and Financial Analysis – This resource from C40 provides step-by-step guidance for local government staff to carry out high-level feasibility and financial analysis of PV deployment.

Solar@Scale Guidebook – This local government guidebook developed by the International City/County Management Association (ICMA) provides guidance for improving large-scale solar development outcomes.

2.3 Locally Offered Solar Financing, Cost Reduction Opportunities, and Incentives

Solar Costs

While solar products and purchasing mechanisms are important tools in making solar more accessible, reducing PV costs is also another important factor. Although solar costs have declined substantially over the past decade, cost can still be a barrier to adoption. PV non-hardware, or "soft," costs now constitute more than half of residential and commercial PV system costs as displayed in Figure 7 (Feldman et al. 2021). The main contributors to soft costs include customer acquisition costs, inconsistent building codes, and variable permitting practices across jurisdictions (Davis et al. 2021). Other sources of soft costs include permitting, inspection,

and interconnection; transmission line (if any); sales tax; and engineering, procurement, and construction/developer overhead and profit (Feldman et al. 2021).

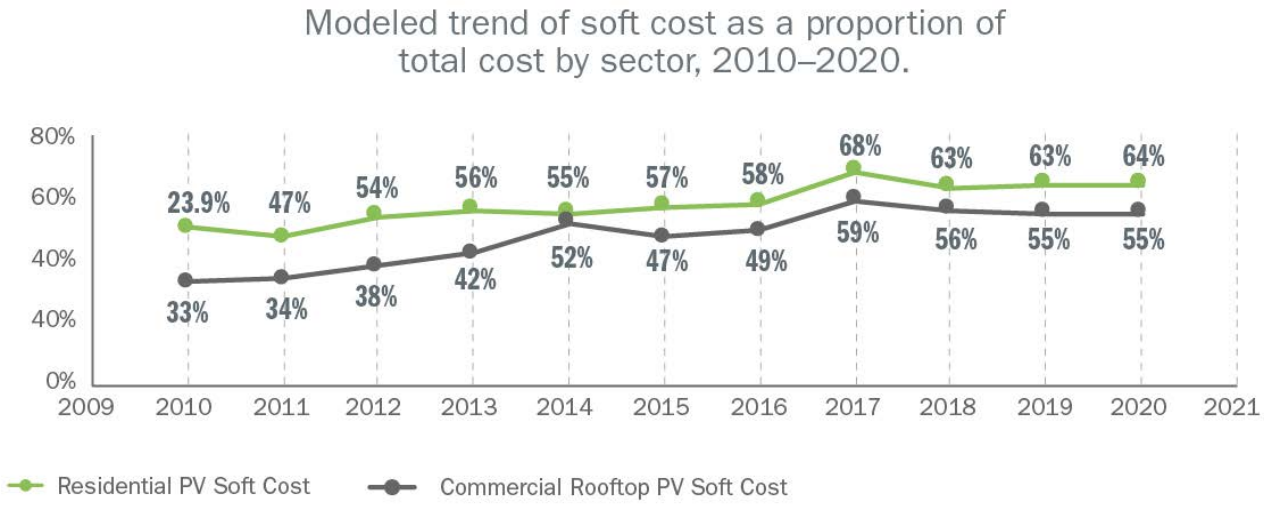

Figure 7. Modeled trend of soft cost as a percentage of total PV costs by sector, 2010–2020

(Feldman et al. 2021)

For more information on cost trends see Solar Technology Cost Analysis | Solar Market Research and Analysis | NREL.

Local governments can play an important role in reducing many of these soft costs, particularly through more consistent building codes and better permitting practices (see Sections 3.2 and 3.3 for more detail). They can also play an important role in lowering customer acquisition costs. In addition, local financing and funding programs can condition offerings on workforce standards that support a diverse local workforce and create jobs. This section discusses financing and incentive options that cities and counties can offer to residents and businesses to help reduce the soft costs of solar systems. The final subsection focuses on options suitable for LMI households. Types of financing and incentive programs available at the state and federal level are discussed in Appendix A.

Resources

U.S. Solar Photovoltaic System and Energy Storage Cost Benchmark: Q1 2020 – This NREL report provides information on PV system costs, including information on residential and commercial soft costs. This document and future updates can be accessed on NREL's Solar Technology Cost Analysis | Solar Market Research and Analysis | NREL page.

Solarize Campaigns

Solarize campaigns, also known as solar group purchases or group buy campaigns, reduce the upfront cost of solar by giving groups of individuals or businesses a discounted rate for bulk

purchases—via savings from reduced marketing costs and economies of scale. Solarize campaigns can reduce solar costs by 20% (Gillingham and Bollinger 2017).

Local governments can organize solarize campaigns or help organize campaigns run by nonprofits, solar installers, or other third parties. In most cases, members of a community who are interested in installing solar are grouped into one purchasing pool, which negotiates reduced system and installation costs with a solar provider.

The following are Solarize campaign implementation tips:

Hold meetings with neighborhood associations or community groups to educate about solarize programs and gauge the level of interest.

Create an online forum for those interested in participating in a potential Solarize program.

If the local government is not administering the program, help the community group or purchasing pool prepare a request for proposals (RFP) for solar vendors, review proposals (based on cost, system type, quality assurance, etc.), select one or more vendors with a record of high-quality installations, and establish a clear contract.

Actively encourage underserved communities, including LMI residents, to participate in the opportunity—for example, through tailored incentives.

Engage with other communities that have experience implementing a solarize program to gain insights into local best practices.

With aggregated small solar projects, there is an opportunity to adopt high labor standards and diversity, equity, and inclusion workforce requirements to ensure that the investments are supporting the development of good-quality and equitable jobs.

Case Studies

Milwaukee Shines Program Grows Solar Locally

The Milwaukee Shines program offers a group buy campaign called Grow Solar in partnership with the Midwest Renewable Energy Association, which has led more than 42 campaigns across the Midwest. Since 2013, solar has been added to more than 200 properties through Grow Solar. Milwaukee was designated a SolSmart Gold city.

For more information, see the Grow Solar home page, Milwaukee Shines home page, and Milwaukee's SolSmart designation page.

Solarize Philly Brings Solar to LMI Residents

The Solarize Philly campaign, led by the Philadelphia Energy Authority, was launched in 2017. It modified the traditional solar group buy structure to enable LMI residents to participate. The program lowered solar adoption costs, but instituted a fee for traditional customers, which guaranteed payments to solar developers providing PV on LMI households (Cook et al. 2019). As of 2021, 6,500 households have signed up for the program, and 98 local jobs have been

created. Philadelphia earned a SolSmart Gold designation for their efforts to remove barriers to solar energy growth.

For more information, Solarize Philly's home page and Philadelphia's SolSmart designation page. See also the NREL report, Up to the Challenge: Communities Deploy Solar in Underserved Markets.

Resources

NYSERDA: 2018 Resource Guide to Solarize Campaign Success – This is a roadmap from NYSERDA for local leaders who want to make solar more accessible and affordable through a Solarize campaign.

Planning and Implementing a Solarize Initiative: A Guide for State Program Managers – This guide by CESA features detailed cases studies of two successful Solarize programs—Solarize Connecticut and Solarize Mass.

Solarize Campaigns: Helping Communities of Color Access Rooftop Solar – This article from RMI discusses how solarize campaigns can reduce energy burdens for communities of color by increasing access to rooftop PV.

Solarize Your Community – This guide from Yale is based on a research project on Solarize Connecticut, a set of campaigns that were launched across Connecticut from 2013 to 2016.

SolSmart Webinar: How To Develop a Solarize Campaign – In this webinar, SolSmart covers the basics of a successful Solarize campaign. Experts from Solar United Neighbors and the Philadelphia Energy Authority share how a Solarize campaign can keep more economic value in the community and how a campaign can be modified to enable participation by LMI customers.

SolSmart's Toolkit for Local Governments: Market Development and Finance – This SolSmart document covers mechanisms available for local governments to increase solar financing opportunities, including loan options, PACE financing, and Solarize campaigns.

Wherever the Sun Shines: Bringing Solar Power to All Households – This guidebook from Yale includes insights from field studies that were conducted during a series of Yale-led Solarize campaigns run by the nonprofit SmartPower.

Green Banks

Green Banks help secure low-cost capital for clean energy projects at favorable rates and terms (e.g., extended terms, low or no money down), which can help residents, small businesses, multifamily housing, and local organizations implement solar projects. Green Banks complement established financing institutions by attracting and leveraging private capital that is not typically accessible to some markets, such as low-income homeowners. Figure 8 illustrates the financial products often offered by Green Banks, in this case the Connecticut Green Bank.

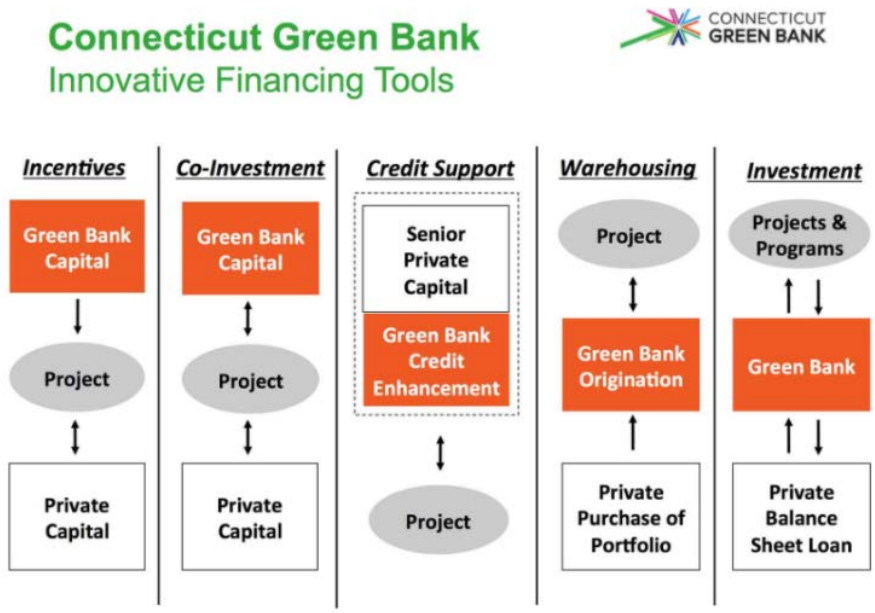

Figure 8. Financing tools offered by Green Banks

(NREL 2021a)

There are a variety of options for forming a Green Bank. Connecticut Green Bank leveraged a $0.001/kWh surcharge on household electricity rates. Montgomery County, Maryland, received $14 million as part of a local utility merger. Nevada's Clean Energy Fund model required startup and capitalization funds to be identified by the board of directors. New York Green Bank was initially funded by ratepayers via surcharges, then bank began generating positive net income with enough revenue to cover operating expenses.

For more information, see NREL's Green Banks web page.

Case Studies

Montgomery County Green Bank

Montgomery County, Maryland, established a local Green Bank through the utility merger of Exelon and Pepco, which provided a $14 million grant. The grant funds are allotted to projects that help build a diverse and equitable future and aid in reducing local greenhouse gas emissions. The Green Bank offers 100% financing for clean energy and energy efficiency projects for multifamily condominiums, homes, businesses, and nonprofits. As of 2021, it has funded $2.5 million in projects on seven properties and 547 households. One notable project is a 286-kW community solar project with 30% LMI subscribers.

For more information, see Montgomery County Green Bank's home page, the 2020 Annual Report, and Montgomery County's SolSmart designation page.

Resources

American Green Bank Consortium – This membership organization helps Green Banks, capital providers, developers, and other clean energy supporters work together to expand and accelerate innovative clean energy investment across the United States.

Coalition for Green Capital Resource Library – For a deeper dive into Green Banks, this resource library from Coalition for Green Capital provides materials on proposed and operating Green Banks in the United States and internationally, as well as other educational information.

Green Bank Network – The Green Bank Network is a membership organization that was formed to foster collaboration and knowledge exchange among existing Green Banks, enabling them to share best practices and lessons learned.

Low-Income Solar Policy Guide: Green Banks – This web page from GRID Alternatives and Vote Solar provides an overview of Green Banks and how they support low-income solar.

NREL's Green Banks web page – This NREL web page gives an overview of Green Banks and the products they provide, as well as information on their formation.

State of Green Banks 2020 – This report from RMI provides information about Green Banks around the world and the progress of new institutions.

What Can Green Banks Do for Rural Areas? – This article from the Environmental and Energy Study Institute provides information on how Green Banks can benefit rural communities.

Property Assessed Clean Energy (PACE) Financing

PACE financing, which is available for residential properties (Residential PACE or R-PACE) and for commercial properties (Commercial PACE or C-PACE), allows residential and commercial property owners to finance the upfront cost of clean energy on a property, then pay the costs back over time through an assessment directly attached to the property through a locally filed lien. The financing covers the cost of the system and can be repaid in terms up to 20 years. Because the repayment period is typically long term, annual energy savings from PACE projects can potentially exceed the annual assessment payment, which could allow property owners to be cash flow positive on their PV system investment. A recent study showed that PACE financing may have increased PV adoption among LMI households (O'Shaughnessy et al. 2021).

PACE must be authorized by state-level legislation and then adopted at the local level. PACE-enabling legislation is active in 37 states plus D.C. C-PACE programs are now active (launched and operating) in 26 states plus D.C. R-PACE programs are currently active only in California, Florida, and Missouri, as displayed in Figure 9 (PACENation n.d.). R-PACE faces significant consumer protection concerns since the tax assessment is superior to the mortgage and may put the homeowner at risk if they are unable to make PACE payments. C-PACE does not face the same consumer protection concerns—programs often require mortgage holders consent to a C-PACE assessment before closing a project. This is reflected in the number of states with C-PACE enabling legislation.

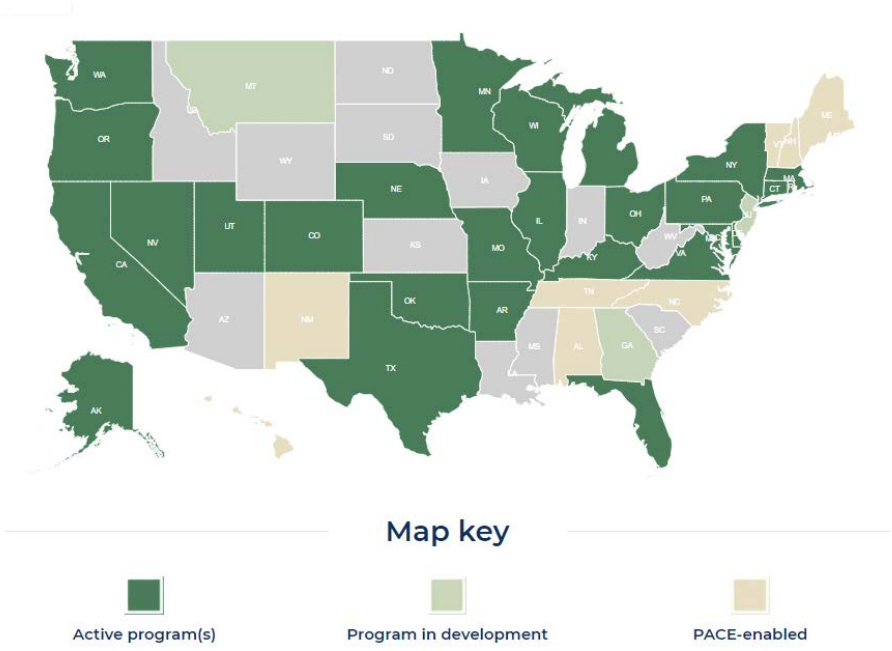

Figure 9. Map of state-level PACE policies in the United States as of January 2022

(PACENation n.d.)

Funding and program administration for PACE programs takes various forms. Public or private funds may be used to finance property improvements. Private capital from national specialty lenders constitutes the significant majority of PACE program funding. Additionally, many PACE program sponsors use third-party administrators to run their PACE programs.

Case Studies

PACE in Sarasota County, Florida

In 2017, the County Commissioners of Sarasota County, Florida, adopted an ordinance that set the framework for both R-PACE and C-PACE financing. The county itself is not offering the PACE program, but the ordinance has allowed four approved providers to offer PACE and financing. Four cities within the county have since opted into the county program. Energy conservation and efficiency, renewable energy, and wind-resistance improvements are all eligible for PACE financing in these jurisdictions. Sarasota County was designated a SolSmart Silver county for actions to increase solar deployment locally.

For more information, see Sarasota County's PACE home page, SolSmart case study, and SolSmart designation page, as well as the University of Florida's PACE FAQ.

Resources

Guidelines for Residential PACE Financing Programs – These DOE guidelines outline best practices that can help state and local governments, PACE program administrators, contractors,

and other partners develop and implement programs and improvements that effectively deliver home energy and related upgrades.

PACENation – This web page provides information about adopting a local PACE program.

Property Assessed Clean Energy Programs – This DOE resource provides information about commercial and residential PACE financing programs.

Residential Property Assessed Clean Energy (R-PACE): Key Considerations for State Energy Officials – This issue brief from the National Association of State Energy Officials (NASEO) details the basic mechanism of an R-PACE program and the considerations that state energy officials should account for when enabling PACE programs at the state level.

SolSmart's Toolkit for Local Governments: Market Development and Finance – This SolSmart document covers mechanisms available for local governments to increase solar financing opportunities, including loan options, PACE financing, and Solarize campaigns.

2.4 Solar Financing for LMI Households

The options described in Sections 2.1, 302.2, and 2.3 can help overcome some solar adoption barriers for LMI households, but not all.

The following are additional financing mechanisms suitable for promoting LMI solar adoption:

- Direct incentives for LMI households include subsidies and direct cash payments.
- On-bill financing, which entails investment by the utility in a solar system, with the solar consumer repaying the utility via their electricity bill; such financing is not dependent on credit scores.
- Loan loss reserves—public funds held in reserve to cover losses due to loan defaults—facilitate solar financing for those with low credit scores.
- Underwriting criteria can be revised to facilitate solar loan access for LMI customers. For example, thresholds for traditional loan requirements can be expanded or alternative metrics can be employed, such as historical utility bill payment or EnergyScore (a patent-pending, machine-learning-based qualification mechanism for rooftop solar customers developed by Solstice).
- Federal resources for financing solar may include the Low Income Home Energy Assistance Program (LIHEAP), Weatherization Assistance Program (WAP), Community Development Block Grants, FEMA funds, and others.
- A building owner can negotiate a new mortgage rate and term to generate additional capital for building improvements, including PV. Capital refinancing is available to owners of large, multifamily housing (Cook and Bird 2018).
- Crowdfunding involves capital sourced largely from public donations, rather than accredited investors, but this mechanism may be difficult to scale (Cook and Bird 2018).

Case Study

On-bill Financing in Grand Junction, Colorado

Grand Valley Power, an electric cooperative based in Grand Junction, Colorado partnered with GRID Alternatives to implement a 25kW community solar project dedicated to low-income customers in 2015. Participants are able to sign up for 4-year subscription terms with no upfront costs., and instead simply pay a 2-cent per kilowatt-hour fee on their existing electric utility bill to cover the cost of their subscription. Participants receive a bill credit resulting in approximately $600 of annual bill savings per customer. Project costs were primarily covered via grants from the Colorado Energy Office and Housing Resources of Western Colorado NeighborWorks.

For more information, see the case study featured on the Low-Income Solar Policy Guide's On-Bill Financing page and Insights from the Colorado Energy Office: Low-Income Community Solar Demonstration Project.

Resources

Affordable and Accessible Solar for All: Barriers, Solutions, and On-Site Adoption Potential – This NREL report reviews the market and regulatory barriers to low-income solar access and affordability and summarizes current solutions to those challenges.

Low-Income Energy Affordability: Conclusions from a Literature Review – This report from Oak Ridge National Lab studied more than 180 publications pointing to promising ways of addressing energy affordability through inclusive solar programs, leveraged health care benefits, grid resiliency, and use of behavioral economics and data analytics.

Low-Income Energy Affordability Data (LEAD) Tool – This tool from DOE provides estimated low-income household energy data at state and local levels. Data include energy burdens, housing units, and income levels.

Low-Income Energy Library: Federal Resources and Tools – DOE created this tool to provide a one-stop location for low-income energy resources across the federal government, including financing.

Low- and Moderate-Income Solar Policy Basics – This web page from NREL gives an overview of LMI solar, including barriers to LMI solar uptake, financing mechanisms, and information on community solar, as well as providing additional resources.

Low-Income Solar Policy Guide: Financing – This web page from the Low-Income Solar Policy Guide, developed by GRID Alternatives and Vote Solar, lists policy tools that provide options to expand access to financial solutions for low-income families to access solar.

Unlocking Solar for Low- and Moderate-Income Residents: A Matrix of Financing Options by Resident, Provider, and Housing Type – This NREL report identifies the most promising strategies policymakers might consider using to finance PV for LMI customers across three housing types: single-family, multifamily, and manufactured housing.

SolSmart's Toolkit for Local Governments: Market Development and Finance – This SolSmart resource offers specific financing tools local governments can utilize to increase solar adoption in LMI households.

3 UPDATING LOCAL POLICIES AND PROCESSES

The local legal and regulatory framework forms the foundation for building a sustainable solar market. Effective and streamlined local rules and regulations help reduce installation costs and can significantly increase adoption rates for solar energy. State and local governments have overlapping authority in some regulatory areas; other areas fall exclusively under local jurisdiction. In fact, some of the most critical barriers to widespread adoption of solar energy can be removed only by local governments.

This section helps community leaders identify which rules and regulations are in place in their community, and where they can make improvements to accelerate solar energy development.

3.1 Solar Access and Solar Rights Laws

Solar access is the ability of a solar owner to receive sufficient sunlight to operate the system productively, for example solar such as tree shading which may cause solar exposure conflicts. Solar rights refer to a property owner's right to install a solar energy system. Prohibitions that restrict a property owner's ability to install a system, such as building height restrictions, impact solar rights. Solar access and solar rights laws encourage the adoption of solar energy by increasing the likelihood that properties will receive sunlight suitable for solar energy production, protecting the rights of property owners to install solar systems, and reducing the risk that systems will be shaded and compromised once installed. By logically incorporating solar energy considerations into zoning codes and ordinances, local governments can bring clarity to the responsibilities of various parties, achieve balance between stated government priorities, and avoid costly and time-consuming legal action.

Solar access can be protected via solar easements and solar access regulations. Solar easements allow a solar array owner to make a voluntary, but legally binding, agreement with neighbors that protects their access to sunlight. For example, the neighbor may agree to limit tree growth. Often, the neighbor is compensated. The solar easement is tied to the property. Solar access regulations limit the degree to which new construction can shade adjacent properties to protect the amount of sunlight that a solar system receives.

Solar rights are mostly addressed via zoning ordinances and development standards, though they may also be addressed through state-level legislation. There may be a correlation between increased levels of installed solar capacity per capita and references to solar in the municipal code (Cook et al. 2016). The American Planning Association notes that excluding solar from local codes, plans, or policies is a barrier to solar adoption (Morley and Ross 2014). Clear relevant codes and standards, such as zoning rules, help streamline solar development (see Section 3.3).

The following are solar deployment considerations relevant to zoning ordinances, adapted from SolSmart's Toolkit for Local Governments:

- **Comprehensive Definitions:** Including definitions of types of solar systems (solar energy system, rooftop PV, ground-mounted PV, large-scale system, small-scale system, energy storage, etc.) in zoning ordinances provides clarity and reduces barriers to solar deployment.
- **Use by Right:** Allowing small rooftop or ground-mounted installations (or installations that include energy storage) without special zoning review in all major zoning districts streamlines the process for small-scale projects.
- **Accessory Structure Setbacks:** Setbacks are requirements to offset structures from property lines. Accessory structure setbacks are usually less restrictive than setbacks required for principal structures, and therefore are appropriate for ground-mounted solar.
- **Height Exemptions/Allowances:** Height restrictions for buildings may limit some solar installations, but zoning can exempt rooftop solar from these restrictions or give special accommodations, such as greater height allowances.
- **Historic Buildings:** Clear guidance on historic preservation ordinances and the process for solar projects on historic buildings or in historic districts streamlines the process and reduces barriers.
- **Ground-Mounted Solar:** Large-scale, ground-mounted solar is often limited to industrial zoning districts. Expanding the zones in which ground-mounted solar can be installed can reduce barriers to solar development.
- **Tree Replacement:** Mandates that require replacement of trees cut to enable solar generation can lessen potential conflicts. Replacement trees can be planted in areas that will not impact solar.
- **Solar-Ready Ordinances:** See Section 3.2.
- **Appropriate Safety Requirements:** Appropriate and non-excessive fire setback requirements help reduce barriers for rooftop solar installations.
- **Aesthetic Requirements:** When solar systems can be displayed openly and are exempt from aesthetic requirements, such as from homeowner associations (HOAs), there are fewer barriers to deployment.
- **Impervious Surface Regulations:** Although ground-mounted solar installations are impervious, they can be exempted from impervious surface limitations because the ground in between the panels is permeable.

Case Studies

California Shade Control Act

The Shade Control Act provides solar access protection for solar system owners in California. It considers any tree or shrub that shades over 10% of a PV system at any time between 10 a.m.

and 2 p.m. a private nuisance (not a criminal offense). This only applies to trees or shrubs planted after the PV system has been installed. The PV owner can seek legal action against the owner of the shrub or tree to reduce the shading.

For more information, see California's Solar Shade Control Act: A Review of the Statutes and Relevant Cases, California Solar Easement and the Solar Shade Control Act: Program Overview, and the Solar Shade Control Code.

Solar in a Historic District in Plano, Texas

The Downtown Heritage Resource District in Plano, Texas, includes the city's historic downtown and is included in the National Register of Historic Places. The design standards for this district are meant to "promote rehabilitation and redevelopment that is sensitive to the surrounding historic context." The standards include guidance on how to install solar and wind technologies, such as locating panels at the back of buildings or using color schemes/materials that match the historic building.

For more information, see Design Standards and the Downtown Heritage Resource District Story Map.

Michigan Solar Zoning Database

The Michigan Department of Environment, Great Lakes, and Energy (EGLE) created a database of zoning ordinances for all jurisdictions in the state. It is a free resource for local government officials, residents, and developers that is meant to increase data and transparency around the status of zoning ordinances and processes regarding renewable energy. This is the first tool of its kind in the United States.

For more information, see the Michigan Zoning for Renewable Energy Database and EGLE Launches Unique Renewable Energy Ordinance Database of Michigan Communities.

New York Prohibits Unreasonable Restrictions From Homeowner Associations

In 2021, New York State enacted legislation that prohibits HOAs from restricting solar system installations with "unreasonable limitations," including inhibiting the system from functioning at maximum efficiency or increasing solar installation or maintenance costs by more than 10%. The law also requires HOAs to detail the justification for any solar installation rejection and allows the private right to sue HOAs for violating the law.

For more information, see NY State Senate Bill S2997.

Resources

Are You Solar Ready? – This article from the American Planning Association discusses seven steps communities can take to prepare for large-scale solar development.

Best Practices in Zoning for Solar – This blog post from NREL discusses best practices for zoning for solar and provides additional resources.

Implementing Solar PV Projects on Historic Buildings and in Historic Districts – This report from NREL provides guidance on implementing PV on historic properties, including how to engage stakeholders, follow review procedures, implement projects, and evaluate impacts.

Model Zoning for the Regulation of Solar Energy Systems – This document from the Massachusetts Department of Energy Resources provides model zoning language and guidance to local governments to establish standards that facilitate solar energy development.

NYSERDA Solar Guidebook – This guidebook includes the "Model Solar Energy Local Law" which local officials may use when adopting their own rules for solar development.

Planning, Zoning & Development – This section from the SolSmart Toolkit for Local Governments discusses how communities can integrate solar into local zoning codes and planning documents.

Solar Access Guide – This guide from the city of Boulder, Colorado, provides information about the solar access regulations that apply to construction.

Solar Access: Issues and Policy Options – This blog post from NREL discusses solar energy access and the policy landscape around solar energy access.

Solar Guidance and Model Ordinance Development – This resource, developed by the state of Rhode Island Office of Energy Resources, includes two solar siting guidance reports and an informational PowerPoint for municipalities to help explain the state's regulations.

Solar Panels on Historic Properties – This guide from the National Park Service discusses how solar panels can be installed on historic properties.

U.S. Climate Alliance: Solar Deployment Guidebook – This guidebook from NASEO was designed to equip state and local agencies with tools, strategies, and models on proven soft cost reduction methods in the following areas: permitting and inspection; zoning and siting; municipal procurement; and property taxes.

What Is a Solar Easement? – This article from EnergySage discusses solar easements and lists states that allow solar easements. It also briefly discusses solar access laws.

3.2 Solar Requirements for New Construction

Solar mandates and solar-ready policies for new construction have become more common in the United States, and local governments can consider these strategies for increasing solar accessibility and deployment. Solar-ready policies require that measures be taken to ensure that solar can be adopted with minimal structural barriers in the future, such as designing roof trusses for additional load and installing conduits for housing wire. Solar mandates require new construction to be equipped with PV. Installing solar on new construction is $0.65/W less expensive than retrofit installations, which is 24% cheaper than a retrofit installation, primarily due to lower customer acquisition and permitting, inspection, and interconnection costs, as well as reduced costs from efficiencies in labor (Feldman et al. 2021).

California was the first state to institute a solar mandate, requiring all new residential buildings three stories and under to install rooftop PV (California Energy Commission 2019). In 2019, Massachusetts proposed a policy that would require new buildings to be capable of hosting solar (192nd General Court of the Commonwealth of Massachusetts 2020). Such approaches are also being implemented at the local level, for example by New York City, Austin, St. Louis, and Tucson (New York City Council 2019; City Council of the City of Austin 2017; St. Louis Board of Alderman 2020; City of Tucson Planning and Development Services Department 2008). These policies can help increase accessibility to rooftop PV, replace the upfront cost of installing solar with costs spread over long-term mortgage payments, and contribute to achieving local, state, and national clean energy goals.

Solar requirements may increase home prices. However, the electricity bill savings over time still allow homeowners to save money (Department of Energy n.d.).

Case Studies

Solar-Ready in Austin, Texas

In 2017, Austin City Council adopted a solar-ready policy that updated the city's local energy construction code. The amendment requires all residential development over 800 square feet, all multifamily buildings, and all new commercial buildings over 2,000 square feet to be capable of hosting rooftop solar panels. Although no structural changes are required by this mandate, buildings that meet these conditions must designate a solar-ready zone on the roof of 240 square feet for residential homes, 35% of roof space for multifamily buildings, and 25% of roof space for commercial buildings. The solar-ready requirement can be avoided by installing at least 2 kW of rooftop PV at the time of construction. Other exceptions to the mandate also apply. Austin was designated a SolSmart Gold city for its many actions taken to increase access to and deployment of solar.

For more information, see Austin's Solar Ready Guidelines, Austin's Solar-Ready Ordinance, Austin's SolSmart designation page, and this article from the Sierra Club Lone Star Chapter: Ready for Solar? Austin Becomes Third City in Texas to Make New Buildings "Solar-Ready."

Commercial Solar Mandate in Watertown, Massachusetts

In 2018, Watertown, Massachusetts, voted to require that new commercial construction must include solar power. The new zoning amendments require that new commercial construction and retrofits to buildings greater than 10,000 square feet, as well as all new residential structures with 10 or more units, include rooftop solar energy. Each building that meets these conditions must install a solar system equivalent to 50% of the building's roof area as well as 90% of any uncovered garage area. There are some exemptions to this mandate, such as buildings that are shaded for more than 50% of daylight hours.

For more information, see the Planning Board Zoning Amendments, this press release from the Massachusetts Municipal Association, and this PV Magazine article: Solar Required on New Commercial Buildings in Massachusetts Town.

Resources

Becoming a Solar-Ready Community – This guide, developed by the state of Michigan for local governments, provides a 10-step process to adopting solar-ready policies at the local level. Although the guide was developed for Michigan communities, these steps can be applied by jurisdictions across the country.

Solar Ready KC – This white paper from the Mid-America Regional Council discusses best management practices for solar installation policy in Kansas City, Missouri, and includes a section on the benefits of and necessary steps for adopting ordinances that promote solar-ready construction.

Solar Ready: An Overview of Implementation Practices – This NREL resource summarizes technical considerations for solar-ready building designs.

Solar-Ready Building Design: A Summary of Technical Considerations – This NREL report, intended for local, state, and federal decision makers, discusses tools and methods for promoting widespread solar-ready building practices. It also includes sample legislation drafted to require that new residential and commercial construction be solar ready.

3.3 Streamlined Solar Permitting and Inspections

Significant variability exists in PV permitting and inspection processes across U.S. communities, which can increase PV soft costs, and delay installations. PV permitting and inspection processes can further cause customer cancellations, thus hindering deployment (Cook et al. 2021).

Where PV is not yet common, permits take longer to review due to unfamiliarity with PV system applications, non-solar-specific permitting processes, or complex permitting or review requirements. Even communities where solar is common may face permitting and inspection delays due to large volumes of applications and limited staff resources. Streamlining PV permitting and inspections can allow more residents and businesses to receive solar at a faster pace. Considering residential battery storage permits can also facilitate the growth of solar plus storage in communities. This section discusses best practices for streamlining permitting and inspections.

Simplified PV Permitting

A simplified permitting process allows residential and small commercial PV applications to be approved quickly and easily. Larger PV systems typically require a more complex review. A jurisdiction can make guidelines about eligibility for the simplified process easily accessible to homeowners, businesses, and local installers. For guidelines on creating a standardized process to review small-scale PV permit applications, visit SolSmart's Solar Permitting Page.

TIP

SolSmart also identifies permitting best practices, which are summarized here:

- **Adopt an instant permitting process:** Instant permitting platforms can reduce the time spent on solar permit applications. For example, NREL's free Solar Automated Permit Processing (SolarAPP+) tool automates the solar plan review process for residential PV permits to install code-compliant residential PV systems. SolarAPP+ can be integrated with existing government software. Some localities have their own instant solar permitting software.
- **Implement an online submission process:** An online submission process enables all information to be submitted to one place and can quickly identify missing information.
- **Coordinate interdepartmentally:** A jurisdiction can avoid delays by coordinating a clear pathway and timeline for permit approval by multiple departments (e.g., electrical, building, fire), or by developing a memorandum of understanding so only one department is approving multiple aspects.
- **Hire or train solar-focused staff:** Many city or county staff members work on various projects, but training a few to work specifically on solar permit approval can allow permits to be approved more quickly.
- **Publish an online permitting checklist:** An easily accessible online checklist can increase process transparency and enable homeowners, businesses, and installers to submit more complete applications by educating them on specific requirements. When applications are complete and correct, city or county staff spend less time reviewing them.
- **Coordinate a regional unified permitting process:** Coordinating PV permit requirements through a regional organization of governments can reduce process variability and help solar developers complete processes more quickly.
- **Review and update safety code requirements:** Removing the unnecessary elements of safety codes has no discernable impact on the safety and quality of the resulting solar installations, as has been proven overseas, and leads to a more streamlined process.
- **Update permit fee structures:** Reducing or eliminating permit fees incentivizes solar installations. If solar permit fees are used, a clear fee structure adds transparency for homeowners, businesses, and installers.
- **Collect stakeholder feedback:** Soliciting stakeholder feedback helps ensure that permit processes are equitable (see Section 1.3).

Inspection Best Practices

After receiving a permit from the local jurisdiction and interconnection approval from the utility, a solar developer can install a PV system. However, most jurisdictions and utilities require the system to be inspected and approved by the local building department before operation. Some jurisdictions and utilities also require fire safety and/or other inspections. Inspections help verify that an installation is safe and compliant with all local requirements.

SolSmart's best practices for PV system inspections are summarized here:

Develop a local inspection checklist: Different inspectors may interpret codes in different ways. An inspection checklist can help overcome this barrier, reducing the time required compared with relying on project designs and plans alone.

Publish inspection requirements online: Publishing requirements online makes the information easily accessible to those who need it.

Set and enforce time requirements for inspections: Time requirements can be set for the time of day an inspection is conducted and how long it should take.

Develop an online system to track inspections: An automated online system for all parties to schedule, track, and communicate inspection times and statuses can help inspectors meet requirements and inform customers of important updates.

Eliminate intermediate inspections: Intermediate (rough-in) inspections take place before installation is complete. Jurisdictions can eliminate these inspections and instead ensure the installation complies with all local codes during the final inspection.

Understand the local utility's requirements: Some utilities may conduct their own inspections, whereas others rely on jurisdictions to ensure safety and code compliance. Jurisdictions can provide a more transparent and streamlined process by understanding utility requirements and communicating with the utility about the inspection process.

Allow virtual inspections: Some jurisdictions have begun using virtual inspections via video calls to reduce travel time and costs.

A jurisdiction may also consider adopting responsible contractor standards. A local jurisdiction could fast-track inspections for solar contractors that meet certain conditions, such as OSHA certification of on-site workers, evidence of labor and wage law compliance, history of quality workmanship, and evidence of a skilled and trained or licensed workforce.

Interconnection

Every distributed PV system must secure an interconnection agreement from the utility before operation to ensure that the system operates safely within the broader electrical grid. This process typically runs in parallel with permitting. Utility interconnection delays are a common problem, which can impact residential projects as well as large-scale and community solar

projects. Having a sense of the local utility's approval times and having a solar specific contact at the local utility may help mitigate potential timeline issues.

Read more about interconnection on NREL's Interconnection Standards web page and at the Interstate Renewable Energy Council's (IREC's) Model Interconnection Procedures.

Process Transparency

The processes required for solar deployment (inspections, permitting, etc.) are often long, costly, and difficult to navigate, which hinders solar deployment. Increasing the transparency of these processes provides many benefits. Local governments save money. Standardized and transparent processes reduce market entry barriers and local distrust. Less red tape and easier processes reduce the soft costs of installing solar. User-friendly interfaces help inform and protect installers and consumers. Clarity and transparency help ensure that solar can expand into underserved areas and help reduce income-based and other social disparities in solar adoption.

Best practices for transparency include the following:

- **Permitting Website:** Create a website dedicated to solar permitting where installers and residents can access resources (including clear permitting checklists and permit templates), track permit statuses, and better understand the permitting process. This may include an online permitting system that allows users to submit, review, pay for, and print permits online. One example of an online instant permitting system is SolarAPP+.
- **Data Availability:** Make data accessible through dashboards and visualizations. Westminster, Colorado, has a Solar Installation Permit Tracker that maps permits issued by year, month, and location.
- **Time Windows:** Require specific, limited time windows for inspections and communicate these time windows clearly to stakeholders.
- **Fee Communication:** Clearly communicate solar permitting fees and changes in fees.

Case Studies

Instant Solar Permitting in Tucson and Pima County, Arizona

In 2021, Tucson and Pima County, Arizona, launched an instant permit approval tool for residential rooftop PV known as SolarAPP+. Previously, contractors needed to wait up to three weeks to receive a residential rooftop PV permit. SolarAPP+ automates the review process and approves correct, eligible rooftop solar applications instantly. Adopting this tool has allowed Pima County and Tucson staff to focus on more complex permits that require in-depth review, while common residential rooftop PV permits are approved without any delay. Pima County has also created an online permitting checklist and trains inspection and permitting staff on PV, which helped them earn a SolSmart Gold designation.

For more information, see this article from Tucson and Pima County, SolarAPP+, and Pima County's SolSmart designation page.

Chattanooga Turnaround Time

Chattanooga, Tennessee, reviews and responds to all solar permit submissions within three business days. This turnaround time is possible partly due to changes in the zoning code. A portion of the code was rewritten to help keep solar as an accessory structure, which requires less staff review time and thus streamlines the process for small ground-mounted and rooftop systems. Chattanooga is a SolSmart Gold designee.

For more information, see Chattanooga Solar Panels and SolSmart's case study on Chattanooga.

Inspection Transparency in San Joaquin County, California

The county of San Joaquin, California, updated its web page to provide transparency into its inspection processes. At the top of the page are public-facing data on the number of inspections by sector dating back to 2019. The page also shares a list of "Today's Inspections," which is updated daily with inspection and permit details. The same page also provides checklists and informational handouts for download on each specific permit type, including PV.

For more information, see San Joaquin County's building permit page and their solar PV system permit checklist.

Resources

IREC Model Inspection Checklist for Residential Rooftop PV – This model checklist incorporates the best components of checklists from various leading U.S. jurisdictions.

NYSERDA Solar Guidebook – This guidebook includes a section on 'Solar Permitting and Inspecting' which reviews the solar permitting and inspection process for local government officials and authorities having jurisdiction (AHJs), as well as the New York State Unified Solar Permit Application and Field Inspection Checklist.

Permitting Best Practices Make Installing Solar Easier – This fact sheet from NREL outlines seven best practices to improve permitting for PV; many include ensuring transparent processes.

Solar Ready KC – This white paper from the Mid-Atlantic Regional Council discusses best management practices for solar installation policy in Kansas City, Missouri, and includes a section on process improvements for the solar installation permitting process.

Solar TRACE – The Solar Time-Based Residential Analytics and Cycle Time Estimator (Solar TRACE) tool from NREL can help increase the transparency of soft costs like permitting, inspection, and interconnection.

SolarAPP+ – SolarAPP+ is a free online web portal developed by NREL that automates the plan review and process for issuing permits to install code-compliant residential PV systems.

SolSmart Program Guide – This guide outlines the criteria for being designated a SolSmart community, many of which involve process transparency. The guide also includes specific examples and templates.

SolSmart Workshop: Best Practices for Solar PV Permitting Session 1 and Session 2 – These recorded workshops discuss how to improve PV permit review and train inspection staff on best practices for inspecting PV systems.

SolSmart's Solar Permitting Page – This page provides the steps necessary for a local government to implement a simplified permitting process.

SolSmart's Toolkit for Local Governments: Solar PV Construction – This guidebook presents information on codes, permitting, and inspection, including the benefits of simplified processes and best practices.

U.S. Climate Alliance: Solar Deployment Guidebook – This guidebook from NASEO was designed to equip state and local agencies with tools, strategies, and models on proven soft cost reduction methods in the following areas: permitting and inspection; zoning and siting; municipal procurement; and property taxes.

4 DEVELOPING LOCAL WORKFORCE TRAINING AND EDUCATION PROGRAMS

A robust solar workforce is a critical pillar of developing a local solar energy industry. Adopting labor standards and signing project labor agreements or community workforce agreements signals demand for a qualified workforce, thus attracting and retaining workers in the industry. Education and training programs can help prepare and develop that workforce. For solar installers, training programs help ensure consistent installer competency and, through increased consumer satisfaction, can help drive additional local demand for solar installations. Solar installer training can also help transform the careers of individuals formerly employed in industries requiring relevant skills, such as the electrical and construction industries. This section covers solar installer training, education at the K–12 level and higher, and broader workforce development issues.

4.1 Solar in K–12 Schools

Solar is being used by schools across the United States, and solar educational materials have been incorporated into K–12 curricula. To integrate solar energy education into a K–12 curriculum, local leaders must work within established state and local curricula guidelines, create a mechanism for training teachers to deliver the information, and consider how teachers can show students a solar system in action. This section discusses how solar has been installed on schools and integrated into K–12 curricula and vocational trainings.

Solar Schools

Introducing solar into the local school system increases solar education and firsthand experience with the technology. In 2020, the Brighter Future Study found that the number of U.S. schools with solar had increased by over 81% since 2014, to a total of 7,332 schools. More than 5 million students now attend schools with solar. About 80% of schools with solar have financed their systems through third-party ownership (Wood et al. 2020).

TIP

Schools can gain the following benefits by installing solar:

Reduce energy costs and provide funds for other important efforts, such as raises for teachers (see the Batesville, Arkansas case study below).

- Reduce carbon emissions and inspire the community by encouraging staff, students, and their families to make clean energy choices at home.
- Provide students with hands-on learning opportunities and job training.
- Contribute to local resilience by turning the school into a local resource for safety and comfort during disasters.

This list was adapted from the Brighter Future Study.

Solar Curriculum and Job Training

By going solar, schools can also use project-based data for energy-themed lessons and professional development. Many U.S. schools are integrating solar and energy systems into their science, technology, engineering, and mathematics (STEM) curricula. Lessons on topics such as energy efficiency, energy storage, and use of solar for powering motors, lights, and so forth can be adapted to any grade level.

The following tips can help integrate solar into curricula:

Draw from curricula that have been developed in other school districts.

Work with local and state curriculum developers to ensure the materials meet the standards for education.

Offer the curriculum to local educators and train them to use it properly. Involving teachers early helps build support for adopting the curriculum.

Develop a "solar for schools" program that includes not only curriculum, but also incentives for installing solar systems, monitoring energy production, loading data onto a website, and using those data as a tool within the curriculum.

Work with local solar owners to create field-trip destinations for students and distribute the list to teachers, particularly at schools without on-site solar.

High school vocational training can build awareness of solar work and help equip workers with the skills necessary to succeed in solar or related construction activities. To implement a solar job training program, schools can partner with local solar installers or organizations such as GRID Alternatives, Solar Energy International (SEI), or local union apprenticeship programs, which provide solar educational and skills training programs to students.

Case Studies

Energy Savings Allow for Investments in Teachers in Batesville, Arkansas

In 2017, the Batesville School District in Arkansas was underfunded by $250,000 and paying the lowest teacher salaries in the county. The district partnered with solar developer Entegrity to install a 759-kW system, the largest solar installation of any school district in Arkansas. The district also implemented energy efficiency updates such as lighting upgrades. As part of the project, teachers were trained on how to incorporate solar technology into the STEM curriculum. As a result of the system and upgrades, the school district reduced energy consumption by 1.6 million kWh per year, which was projected to save more than $4 million over 20 years. A portion of those savings help fund pay for teachers. The district now ranks first in the county for teacher salaries.

For more information, see Generation180's Batesville case study.

Training High School Students for Solar Careers in Delta County, Colorado

In Delta County, Colorado, the secure and high-paying mining jobs that graduates often gravitated toward have become less available since two of three local mines declared bankruptcy in recent years. Through a partnership with SEI and Empowered Energy Systems LLC, solar installation has become a new job opportunity for students—supported by training at Delta and Paonia High Schools. To date, students have designed and installed two local systems: a 10-kW system and a 5-kW system. The 10-kW project will save the school over $1,500 per year.

For more information, see SEI's case study and Innovative Solar System's web page.

Resources

A Guide to Zero Energy and Zero Energy Ready K–12 Schools – This guide from NREL outlined outlines the steps and documents the process of creating a zero-energy school and can provide a strong foundation for future zero energy school projects.

Brighter Future How-To Guide – This guide from Generation180 helps schools get started with solar to receive benefits such as financial savings, educational opportunities for students, energy resilience, and healthier families and communities.

Brighter Future Report 2020 – This study on solar in U.S. schools from Generation180 discusses how schools can implement solar into their curricula and job training, and includes new data and trends on solar uptake at schools nationwide as well as case studies for specific school districts.

GRID Alternatives Solar Futures – GRID Alternatives created the Solar Futures program to provide classroom and hands-on solar education to K–14 students, with a focus on high school juniors and seniors, to illuminate career pathways in the solar industry.

K-12 Solutions for Building Energy Excellence –This document shares practices, programs, and policies that help advance clean energy goals and build energy literacy in STEM curricula.

NYSERDA P-12 Schools Initiative – P–12 is defined as pre-kindergarten through grade 12 education. The P–12 Schools Initiative encourages schools to lower energy use and utility bills while reducing greenhouse gas emissions.

Solar Energy International Solar in the Schools Program – This program focuses on training a young workforce for jobs after high school.

Solar For Schools: A Case Study in Identifying and Implementing Solar Photovoltaic (PV) Projects in Three California School Districts – This NREL case study and reference document details the steps and processes that could be used to successfully identify, fund, and implement PV projects in school districts across the country.

4.2 Solar in Higher Education

A growing number of renewable energy programs at institutions of higher education offer certificates as well as undergraduate and graduate degrees, helping increase the number of young

professionals entering the renewable energy sector. In addition, universities, colleges, and community colleges can help local governments pursue solar development (see Section 1.2). Such partnerships can result in a solar internship or fellowship (see Section 1.4) and can help achieve local solar goals while promoting the development of solar professionals.

Academic programs that may provide beneficial partnerships include energy systems engineering, energy science, energy economics, sustainability planning, energy policy, renewable energy management, and so forth. When considering potential institutions for partnerships, communities focusing on equity may consider partnering with Minority Serving Institutions (MSIs) or Historically Black Colleges and Universities (HBCUs). For a list of renewable energy and energy efficiency programs in the United States, visit DOE's list of colleges and universities.

There are also programs and competitions designed for college-level students to inspire and grow the solar workforce, including the following:

Solar Decathlon: DOE's collegiate competition challenges student teams in 10 contests, providing hands-on experience and training to prepare students for the solar workforce.

Solar District Cup: In this DOE competition, multidisciplinary collegiate student teams design and model distributed energy systems for a campus or urban district.

Solar Spring Break: GRID Alternatives offers solar-focused service-learning programs for college students around the country. Students spend spring break installing solar in communities chosen based on economic or environmental justice criteria.

Solar training programs run by Joint (labor-management) Apprenticeship Training Committees (JATCs) or community colleges are well suited to build local solar workforces, with programs focused on system design, safety and maintenance, installation procedures, solar controls, battery technology, and more. For a list of solar training programs and schools, visit the Department of Labor's Apprenticeship Finder, Clean Energy Authority, or HVAC School Search.

Resources

Apprenticeship Finder – This resource from the U.S. Department of Labor provides details on apprenticeship programs and job listings by occupation or keyword and location.

Colleges and Universities – This map from DOE provides information on higher education learning opportunities in energy.

Solar Career Map: About the Industry – IREC provides information about different parts of the solar industry (manufacturing, system design, project development, installation, and operations), as well as jobs, career pathways, and solar training.

SolarCorps Fellowship Program – GRID Alternatives runs an 11-month paid fellowship program for people starting or furthering a career in clean energy.

4.3 Solar Workforce Development

This section provides a snapshot of the current U.S. solar workforce and discusses ways that local governments can promote solar workforce development.

Today's Solar Workforce

Over the past 5 years, solar employment has grown in most states. The U.S. solar industry employed more than 230,000 workers in 2020, a 6.7% drop from 2019; this drop was mostly due to the impacts of COVID-19 (SEIA, Solar Foundation, and IREC 2021). Although there has been an observed decline in 2020, the industry is still expected to see continued growth over time. Employment of solar photovoltaic installers alone is projected to grow 52 percent from 2020 to 2030 by the U.S. Bureau of Labor Statistics (2021). Labor productivity, which is the real economic output per labor hour, of the solar industry reached a record level in 2020, increasing by 19% in the residential sector, 2% in the nonresidential sector, and 32% in the utility-scale sector (SEIA, Solar Foundation, and IREC 2021).

The solar workforce includes jobs related to installation and development (including construction and engineering), manufacturing, sales and distribution, operations and maintenance, and others supported by distributed solar demand. Installation and development jobs constituted the largest segment of the industry in 2020 (Figure 10).

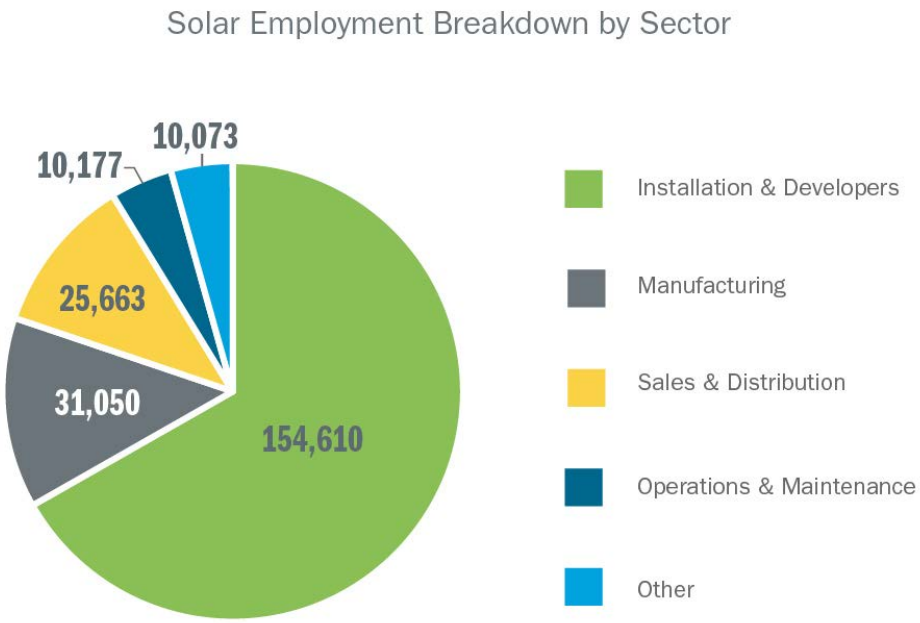

Figure 10. Solar employment breakdown by sector

(SEIA, Solar Foundation, and IREC 2021)

The solar workforce has become more diverse. Women made up about 30% of the solar workforce in 2020, up from 26% in 2019. Hispanic or Latino workers made up about 20% of the solar workforce in 2020, up from about 3% in 2019 (SEIA, Solar Foundation, and IREC 2021). Figure 11 compares the demographics of the solar industry to the broader U.S. workforce.

Despite the growing diversity, there are significant equity gaps in the solar workforce. Women are underrepresented in higher positions in the industry, as are people of color. The Solar Foundation surveyed 300 solar companies and found that the average company's executive team included only white men (The Solar Foundation 2019). In addition, women in the solar workforce make 74 cents on the dollar compared to men. This difference is more pronounced for women of color, who also are less likely to receive promotions in the solar industry than white men and white women (The Solar Foundation 2019).

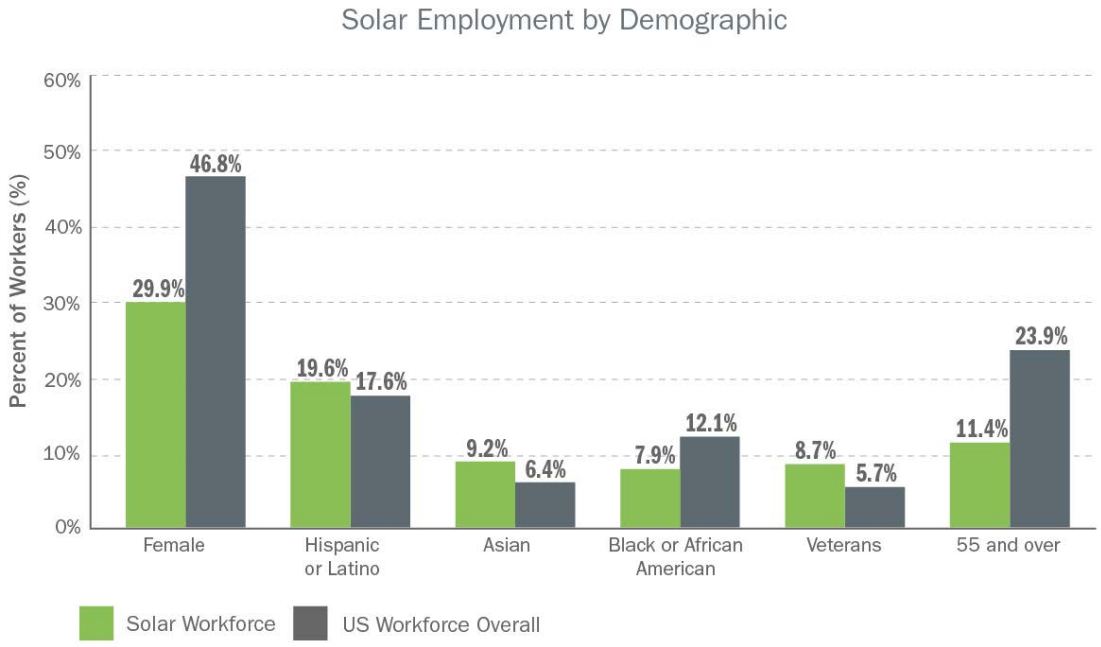

Figure 11. Percentage of 2020 workers by demographic category, solar industry versus the U.S. workforce overall

(SEIA, Solar Foundation, and IREC 2021)

Local Workforce Development

Growing demand for U.S. solar workers is expected to continue. Workforce development can bring local economic benefits while helping local governments meet solar targets. Thoughtful labor standards coupled with workforce development can help ensure that the industry reflects local diversity, that opportunities are widely accessible, and that the jobs created are stable, good-quality, career-track opportunities.

TIP

The following suggestions may help local governments and the solar industry engage with LMI communities and communities of color on solar workforce development:

Partner with local Building and Construction Trades Councils, community colleges, minority-serving institutions, job training organizations, housing authorities, community-based organizations (CBOs), and other organizations that serve LMI and minority communities.

Support quality pre-apprenticeship programs in partnership with local Building and Construction Trades Councils.

Provide hands-on training opportunities, especially paid opportunities.

Provide services such as childcare and transportation for individuals involved in workforce training.

Include skill development in other areas, such as resume development, time management, computer literacy, and financial planning.

Encourage local hiring practices.

Partner with organizations serving previously incarcerated individuals to provide job training opportunities.

Partner with industry players to promote inclusive hiring and retention.

This list is adapted from the Low-Income Solar Policy Guide and the High-Road Workforce Guide for City Climate Action.

Veterans are another important group to consider as the solar industry rapidly grows and the need for skilled, technically savvy workers increases. Currently veterans make up about 8% of the solar workforce (SEIA, Solar Foundation, and IREC 2021). The Solar Ready Vets program from DOE gives information and resources about hiring veterans for the solar workforce. Hiring veterans into solar industry jobs is dually beneficial, helping veterans find employment in jobs that will support the U.S. economy, and helping rapidly expanding solar companies fill their new roles with competent, motivated workers.

Table 3 lists resources for solar job training. Each state has different requirements for solar installers. The IREC National Solar Licensing Database provides the latest licensing, certification, and other requirements that impact the solar industry for every state. Local first responders like fire fighters and other relevant groups like code officials may also consider updating their trainings for Solar PV.

Table 3. Resources for Solar Job Training

Title	Organization	Description
Code Official Training	IREC	This series of trainings covers inspection procedures for microinverter systems, AC-DC converter systems, lithium-ion storage systems, ground-mounted AC-coupled systems with storage, and commercial carport systems. There are also continuing education webinars on topics like safe inspection during COVID-19 and National Electrical Code updates.
Solar PV Safety for Firefighters	IREC	This training for first responders teaches the basics of how to operate safely on a solar-equipped structure.
Solar Permitting Plan Review Course	Solar Training and Education for Professionals; DOE	This training walks participants through a full review of a complete solar installation permit plan application.
NABCEP Board Certifications	North American Board of Certified Energy Practitioners (NABCEP)	NABCEP offers board certifications for many professions within the solar industry, including PV design, solar heating installation, PV installation, and more.
Federally Registered Apprenticeships	U.S. Department of Labor (DOL)	Apprenticeships combine paid, on-the-job training with classroom instruction to prepare workers for highly skilled careers. At the time of publication, there are several hundred solar apprenticeship offerings listed.

Unions

Labor unions will be an integral piece in the push to decarbonize the U.S. energy economy equitably. Local governments can work with local Building and Construction Trades Councils to identify the labor unions and apprenticeship programs that provide opportunities for trainees to access career-track solar training in their communities. Many union training programs teach solar installation to apprentices, as well as offering journey upgrade classes on new and emerging technologies. In addition, the North American Building Trades Unions (NABTU) have developed a pre-apprenticeship curriculum called the Multi-Craft Core Curriculum (MC3) that CBOs, community colleges, and other solar training providers can use to ensure alignment with union apprenticeship requirements. Project labor agreements (PLAs) or community workforce agreements (CWAs) offer another opportunity for partnering with unions. In these negotiated agreements, developers agree to employ union labor at negotiated rates, while the labor unions agree to provide a trained and qualified workforce. These agreements can also specify the work participation of members of local under-resourced communities. When engaged, labor unions can be excellent partners for local solar deployment as well as the realization of economic and equity benefits. DOE has additional information on union jobs and their role in communities.

Case Studies

GreenPower Program in Madison, Wisconsin

In 2016, Madison started a new program to train underemployed and unemployed residents from underrepresented communities in basic PV installation. Trainees work alongside electricians from the city's engineering division to install PV on city facilities and aid in energy efficiency upgrades. As of 2020, GreenPower participants had installed 16 PV projects totaling over 813 kW, helping the city offset an estimated 765 metric tons of CO_2 annually. Participants are also guided in life skills, which can aid in obtaining a permanent job after the training concludes. Participants have gone on to gain electrical apprenticeships and become certified journeymen, and some have been hired by the city.

For more information, see Madison's GreenPower web page.

San Francisco's First Source Hiring and GoSolarSF

San Francisco's GoSolarSF program encourages solar deployment as well as local employment and workforce development. It offers incentives for businesses, residents, and nonprofits that install solar systems using a GoSolarSF-certified installer. A certified installer must work with the Office of Economic and Workforce Development and the First Source Hiring Program to employ San Francisco residents for at least 50% of new hires. The First Source Hiring Program requires that "developers, contractors, and employers utilize good faith efforts toward employing economically disadvantaged San Franciscan residents for entry level positions." The program provides subsidies for on-the-job training, certified job trainings, and specialized services for people with disabilities, veterans, young adults, and those reentering the workforce.

For more information, see First Source Hiring Program.

Solar Works DC

Solar Works DC is an LMI solar installation and job training program spearheaded by the Washington, D.C., Department of Energy and Environment and the Department of Employment Services. The program is implemented by GRID Alternatives Mid-Atlantic, a nonprofit organization. It helps prepare D.C. residents for careers in solar and increases diversity and inclusion in the local solar industry. Participants complete the Installation Basics Training Program, CPR training, and Occupational Health and Safety Administration 10 certifications and take the North American Board of Certified Energy Practitioners PV Associate credential exam. They also have access to wraparound services to help overcome other barriers to employment. The program's goal is to have at least 50% of participants placed in part- or full-time jobs. Part of the training includes the installation of no-cost solar systems on LMI residents' homes. Program participants get real-world experience, and the solar systems save homeowners approximately $600 per year.

For more information, see Solar Works DC and Solar for All Program.

Resources

Cities Renewables Accelerator – The American Cities Climate Challenge is a program from Bloomberg Philanthropies to help cities meet carbon-reduction goals. The Cities Renewables Accelerator, which is part of this program, supports cities with procurement. This program also offers technical assistance on economic inclusion to leverage procurement and other activities to support good local jobs.

Diversity Best Practices Guide for the Solar Industry – This guide from the Solar Energy Industries Association (SEIA) and the Solar Foundation outlines best practices for enhancing diversity and inclusion in solar industry companies.

High-Road Workforce Guide for City Climate Action – This guide provides a step-by-step manual for fostering union engagement, building a workforce collaborative, and undertaking workforce planning activities in a way that supports good-quality jobs and accessible pathways for underrepresented and disadvantaged workers.

Just Energy Policies: Model Energy Policies Guide – This guide from the National Association for the Advancement of Colored People (NAACP) Environmental and Climate Justice Program identifies five policies that can advance the transition to a more inclusive, clean, and equitable energy economy. It includes a section that discusses local, people of color, and women hiring policies.

Just Energy: Reducing Pollution, Creating Jobs Toolkit – This toolkit from the NAACP provides guidance for energy justice organizing.

National Solar Jobs Census 2020 – The National Solar Jobs Census is a collaborative effort of SEIA, the Solar Foundation, and IREC. It tracks domestic solar employment across all solar industry market sectors.

Solar Career Map – This map from IREC describes 40 jobs across four solar industry sectors (manufacturing, system design, project development, and installation and operations) and outlines over 60 potential routes to advance between these jobs.

Solar Decathlon Career Resources – The U.S. Department of Energy Solar Decathlon® fosters collaboration that mimics the real-life workplace environment among students from different academic disciplines, including engineering, architecture, building science, interior design, business, marketing, and communications. These career resources offer information about job opportunities related to competing in the Solar Decathlon, as well as building careers in solar energy, bioenergy, and wind energy.

Solar Energy International – SEI is a nonprofit educational organization dedicated to equitable solar workforce development. This website has training resources, job boards, and other resources.

Solar Ready Vets – IREC leads the Solar Ready Vets Network, a program that connects transitioning military service members and veterans with career opportunities in the solar industry.

Solar Ready Vets Network – This group of solar workforce development programs funded by DOE connects veterans with career training, professional development, and employment opportunities in the solar industry.

Strategies for Workforce Development: A Toolkit for the Solar Industry – This toolkit from the Solar Foundation and the Solar Training Network describes scalable and industry-driven solutions to align training efforts with the needs of the workforce.

U.S. Solar Industry Diversity Study 2019 – This report from SEIA and the Solar Foundation is a study on diversity and inclusion in the solar workforce. It includes information on career pathways, wages, satisfaction, and career development. It also provides strategies that companies can use to increase diversity and inclusion.

5 EDUCATING AND EMPOWERING POTENTIAL CUSTOMERS USING INCLUSIVE STRATEGIES

Local governments can engage their communities using a variety of outreach activities that promote solar energy technologies. These activities can augment the public's knowledge about solar energy, promote consumer confidence, and help consumers decide whether to install solar energy systems on their properties. This section introduces strategies for developing educational materials that address different priorities and barriers, including language-inclusive educational materials and opportunities.

Different groups of people have different priorities related to adopting solar, so targeted inclusive educational materials are important for achieving broad acceptance. Educational resources can include pamphlets, webinars, meetings, and so forth. Goals can include informing the community about the basics of solar and its benefits, government plans and programs, and opportunities for adopting solar. For these resources to be inclusive, they should be accessible in different languages, sensitive to differences in motivation, and tailored to the needs of vulnerable subsets of the community.

TIP

The following are examples of messaging that can be used in educational materials:

If economic benefits are a local concern, emphasize potential bill savings and other economic benefits, including local job creation (see Section 4), increased home values averaging 4.1%, and stable energy prices (Mikhitarian 2019).

Outline the environmental benefits of solar, especially the carbon emission reductions, for more environmentally conscious local interests.

Where energy resilience is a concern, highlight how solar plus storage can improve resilience (see Section 1.6).

For LMI households that may assume solar is financially unfeasible, highlight different financing options (see Sections 2.3 and 2.4).

For renters and households with roofs poorly suited to solar (not large enough, too old, etc.), highlight other solar opportunities, such as community solar or programs that help make homes solar ready (see Sections 3.2 and 6.2).

For renters in multifamily housing, present options for discussing solar installation with building owners (see Section 6.3).

For people who are risk averse and need more evidence of solar benefits, highlight success stories.

Understanding the influence of community peers and trusted organizations helps in developing and distributing targeted educational materials. In fact, influences from peers, social institutions, and local organizations may be powerful considerations for adopters (Bollinger and Gillingham 2010; Noll et al. 2014; Rai and Robinson 2013). For rooftop solar adoption, the likelihood of

additional solar installations increases when more installations are in a geographic area (Graziano and Gillingham 2015). Residential rooftop solar that is more visible from the road may have a greater influence on neighbor adoption than less visible rooftop solar (Wolske et al. 2020). For these reasons, educational materials highlighting a local household that has installed rooftop solar may have a strong influence on the household's neighbors.

Residents and local businesses may use languages other than English. To ensure that educational materials are accessible, written materials can be published in multiple languages, videos can have translations available or be dubbed, and live events can include translators or sign language interpreters.

The following are tips for meeting language needs in the community:

Language: Know which languages are used locally and when/why community members use particular languages. Consider differences in ability and provide accommodations—such as including sign language interpreters at speaking events or printing materials in Braille—in communities with large deaf or blind populations. Engaging with community organizations can clarify specific community needs.

English Proficiency: Understand the difference between social English and academic English. For example, some community members may converse in English but may not read more difficult materials.

Professional Translators: Work with professional translators to establish consistency and understandability in materials. A professional translator can ensure that the meaning and context of a translation are clear.

Community Liaisons: Work with multilingual community volunteers who can serve as liaisons and support households interested in solar.

Case Studies

Rhode Island LMI Solar Strategy and Survey

Seeking to expand LMI access to solar, the Rhode Island Office of Energy Resources surveyed LMI electricity customers to understand the barriers to participation in community solar projects. The survey was also designed to understand LMI individuals' motivations for pursuing solar. After the survey, OER conducted three focus groups to deepen the knowledge gained from the survey. These methods helped OER develop educational and outreach materials about community solar to meet local needs.

For more information, see Expanding Access to Solar for Low-to-Moderate Income Households and Communities: Lessons Learned for State Agencies and Rhode Island Low-Moderate Income Solar Strategy.

Resources

Disadvantaged Communities – Single-Family Solar Homes Program: 2020 Marketing, Education and Outreach Plan – The Single-Family Solar Homes program is administered by the nonprofit GRID Alternatives in California. This document describes the marketing and outreach plan for the program, identifying target audiences and approaches.

GW Solar Institute Education Center – The George Washington University Solar Institute Education Center curates information that is accessible to a wide range of audiences.

Homeowner's Guide to Going Solar – This guide from DOE can help homeowners make solar-related decisions. It is also available in Spanish.

Solar Spotlight: Racial Equity in Solar Adoption

Although U.S. solar deployment has grown steadily over the past decade, deployment has not been equitable for all Americans. Recent analysis shows that rooftop PV adoption rates are significantly lower in Black- and Hispanic-majority census tracts, even when controlling for differences in household income and home ownership (Sunter et al. 2019). Black or African American and Hispanic households are also disproportionally more likely to experience energy insecurity and utility disconnection (Memmott et al. 2021). Local governments are in the unique position to help change this by striving for greater equity in access to solar benefits.

The solar workforce is another area with underrepresentation of certain groups, as reported by the 2020 National Solar Jobs Census (SEIA, Solar Foundation, and IREC 2021). Black or African American individuals, for example, represent 7.9% of the solar workforce, which is below their national workforce representation of 12% (see Figure 11 in Section 4.3). Despite the disparity between the solar workforce and the national workforce, the 2020 National Solar Jobs Census also found that, since 2015, solar industry employment has increased for minorities (see Section 4.3) (SEIA, Solar Foundation, and IREC 2021). Still, changes are needed before the solar industry matches the diversity of the entire country.

The following are ways that local jurisdictions can help create a more equitable local solar market:

Adopt specific goals to ensure racial equity: Goals could include deployment, ownership, engagement, and workforce metrics—addressing who owns and is benefiting economically from solar locally.

Account for historical injustices: Injustices, which may include redlining and environmental contamination in communities of color, should be considered when planning new programs or policy updates. These historical injustices can still impact communities today. For example, previously redlined neighborhoods have fewer trees and higher average summer temperatures, leading to higher air-conditioning needs and costs and health risks (Plumer and Popovich 2020).

Ensure diversity and representation on local advisory committees: If advisory committees are influencing energy decisions, ensure that they are representative of the community. Engage local justice, equity, and diversity groups or CBOs that represent communities of color in the decision-making process.

Include underrepresented minorities in decision-making: See Section 1.3.

Partner with a minority-owned business: When starting a Solarize campaign or another program that involves working directly with a solar installer, partner with a minority-owned

business and seek to be inclusive of local underrepresented groups in the campaign. See Section 2.3 for more information on Solarize campaign.

Create and distribute solar-focused educational materials in all locally relevant languages: See Section 5.

Partner with local schools, universities, and nonprofits on educational and training programs: These entities can incorporate equitable solar training and career development opportunities into their programs and projects.

Learn about "Ban the Box" policies: These policies promote fair hiring and give formerly incarcerated people an opportunity to enter the industry without facing barriers (McLean 2020).

When creating a more equitable solar market, a locality should strive to understand the specific needs of minority or underserved communities and carefully consider where solar may be an appropriate solution. Meaningful engagement of these communities in solar planning processes should provide a decision-making role and avoid tokenism to facilitate input in a way that does not increase the burden on these communities. For more information on effective local engagement strategies, see Section 1.3.

Resources

3 Hurdles to Racial Justice in Clean Energy – And 3 Ways U.S. Cities Can Overcome Them – This article from the World Resources Institute addresses three specific barriers to racial justice in the implementation of renewable energy, as well as local-level solutions help overcome these barriers.

Clean Energy Equity Examples – This resource from the Low-Income Solar Policy Guide is a list of clean energy equity examples at the state and city level, which includes equity advisory, oversight and working groups.

Community Outreach and Solar Equity: A Guide for States on Collaborating With Community-Based Organizations – This guide from CESA is aimed at state energy agencies that are looking to strengthen relationships with local under-resourced communities or that are beginning to engage in energy justice work. The guide is a collection of best practices, ideas, and principles that provide states with a foundation for building equitable relationships with CBOs and working with them on solar development.

Designing Community Solar Programs That Promote Racial and Economic Equity – This white paper from the Institute for Local Self-Reliance provides guidance for creating community solar programs that promote racial and economic equity. It defines what makes a community solar program equitable and states objectives that community solar programs striving to be equitable can pursue, including objectives related to program structure, consumer participation, compensation, and other policy areas.

Diverse Suppliers Database – This database of companies with diverse ownership was developed at the direction of SEIA's Diversity, Equity, Inclusion, and Justice Leadership Council as part of an effort to support and promote diverse businesses in the industry.

Energy Equity for Renters – This initiative from the ACEEE offers many resources, including a guide for local governments, energy burden research, building performance standards, and more.

Solar With Justice: Connecting States and Communities – This CESA project works with state energy agencies and CBOs in under-resourced communities so that they are better able to share the knowledge and information needed for solar to be developed efficiently, equitably, and cost-effectively in LMI communities.

6 INSTALLING SOLAR ON LOCAL LAND AND BUILDINGS

Government buildings can offer structures for PV, directly benefitting the community by adding renewable energy to publicly available communal spaces, reducing government energy costs, and providing educational opportunities. Local governments often own land and facilities near electricity load centers, making them good hosts for renewable energy generation. As the cost of batteries decrease, installing solar with storage is another option for local land and buildings. This section discusses opportunities for siting distributed solar locally.

6.1 Leading by Example With Installations on Government Land and Buildings

Local governments can show leadership by integrating solar into government facilities and properties, including schools (see Section 4.1). Solar on government buildings can directly benefit the community by adding renewable energy to publicly available communal spaces, reducing government energy costs, and providing educational and work opportunities. Leading by example can educate area residents and businesses and encourage them to adopt solar. Local governments often own land and facilities near electricity load centers, making them good hosts for renewable energy generation. Local governments can partner with solar developers, labor unions, and/or utilities on these projects.

TIP

The following recommendations apply to such projects:

Set objectives: Identify the objectives for installing solar on government property, such as receiving the best return on investment, optimizing solar energy production and greenhouse gas reduction, educating the public, or meeting energy sector resilience goals.

Use objectives to identify optimal installation locations and guide site selection: For example, if the main objective is educating the public, the site should most likely be in a high-profile and visible location, such as the library. Conduct site assessments to understand the economics, technical issues, hosting capacity, and energy production potential. Include key staff—such as facility managers, energy managers, and procurement and budget staff—in site assessments.

Select the appropriate financing mechanism: The local government can choose direct ownership or use a third-party financing model (see Section 2.2 for more information). When exploring options, consult with energy managers local budgeting staff, and attorneys who have been through the process. See Appendix A for more information about third-party ownership.

Identify the labor standards: Labor standards are used to ensure that a trained and qualified workforce is engaged in the installation. Labor standards can also establish targeted hiring criteria to engage the participation of underrepresented or disadvantaged populations. Labor standards can also be incorporated into project labor agreements (PLAs) or community

workforce agreements (CWAs) to make sure the project is delivering local economic and job benefits.

Standardize solicitations for solar installations: Use a well-crafted request for proposals (RFP) and evaluation process to streamline the effort and generate more interest from solar developers. Standardizing the process can make future installation solicitations easier. Develop a process and criteria for evaluating bids and ensure that the process is transparent and fair. To access a template solar RFP, see NREL's Request for Proposal Template for Grid-Tied Solar Photovoltaic Systems for State, City, and Other Entities.

Commission the solar system and ensure quality operations: Hiring an independent consultant for system commissioning can ensure that the system meets code requirements, uses installation best practices, and performs as expected. Proactive monitoring and maintenance prolong the lifetime of the system and increase energy output. Contracting operations and maintenance work from the system installer reduces the need for municipal staff time and expertise.

Include educational components in the project: When siting a project, consider the opportunities a site may provide for all levels of public education. The site can be used for field trips, demonstration projects, hands-on personnel training, and research projects. The site could include a publicly accessible placard with easy-to-understand information about the solar system.

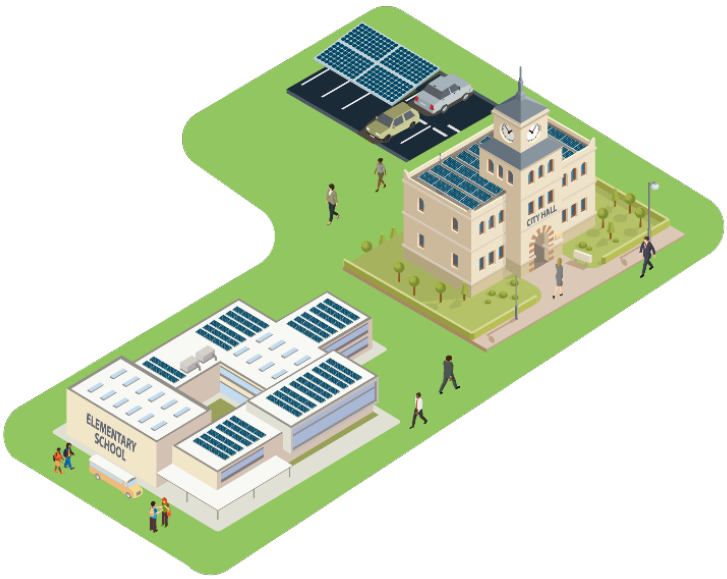

Figure 12. Solar on government land and buildings

Case Studies

Santa Rita Union School District Solar Plus Storage

The Santa Rita Union School District in East Salinas, California, is a preschool through eighth grade school system with four elementary schools and two middle schools. The district installed

solar-plus-storage systems on each school building for power in the event of disasters and grid outages. Each system includes 1 MW of PV integrated with a 1.1-MWh energy storage system. The systems can provide up to seven hours of power at each building during a grid outage, minimizing disruptions to the school day. The systems will also provide bill savings under normal operations. The control system allows the schools to use microgrid operations and pull power from the batteries rather than the utility during periods of high demand and high pricing.

For more information, visit Solar-Plus-Storage Microgrids Installed in Santa Rita Schools.

Edina, Minnesota, Hosts Local Community Solar Garden

The Energy and Environment Commission of Edina, Minnesota, set the goal of becoming a leader in renewable energy. The city created an Electricity Action Plan in 2016 that included immediate and long-term actions around renewable energy opportunities. One step toward achieving these goals is hosting a 618-kW community solar garden on the roof of the Edina Public Works Building, which is available to residents from all income levels. The solar garden serves 68 households. The project resulted from a partnership between the city, Minnesota Interfaith Power & Light, and Cooperative Energy Futures. It became operational in 2018 and is currently fully utilized, with a waitlist for potential subscribers.

For more information, see Edina's Electricity Action Plan, SolSmart's Edina case study, and Edina's SolSmart designation page.

Resources

Brighter Future: A Study on Solar in U.S. Schools – This study from Generation180 includes data and trends on solar uptake in schools.

Procurement Guidance – This guide for cities is from the Cities Renewables Accelerator and was developed by RMI and World Resources Institute to support the Bloomberg Philanthropies American Cities Climate Challenge and the Urban Sustainability Directors Network cities. It helps city governments understand all parts of municipal renewable energy projects.

Solar Decision Support and Resources for Local Governments – NREL offers decision support and resources for local governments that want to go solar. Training webinars cover topics ranging from site evaluation to project financing, as well as case studies.

6.2 Community Solar

For local government-owned land, community solar may be an ideal option. Community solar is a distributed solar energy deployment model that allows customers to buy or lease part of a larger, off-site shared PV system. Community solar subscribers then typically receive a monthly bill credit for electricity generated by their share of the solar PV system, as if the system were located on their premises. Subscriptions are often based on the customer's monthly load or a fixed kilowatt hour/month.

DOE further defines community solar as a solar project or purchasing program, within a geographic area, in which the benefits of a solar project flow to multiple customers such as individuals, businesses, nonprofits, and other groups. Benefits can include a low or zero upfront investment, ability to subscribe without owning a home or suitable roof space, reduced monthly energy bills via virtual net energy metering (VNEM),[11] and buy-in to clean and renewable energy for subscribers. Community solar projects can be sited in a variety of spaces, such as large rooftops, LMI neighborhoods, public lands, or brownfields.

Community solar projects can be sited in a variety of spaces, including LMI neighborhoods, public lands, or on a former industrial or commercial site that may be contaminated known as a brownfield. Communities can host a community solar project or incorporate community solar into their carbon-reduction and renewable energy goals.

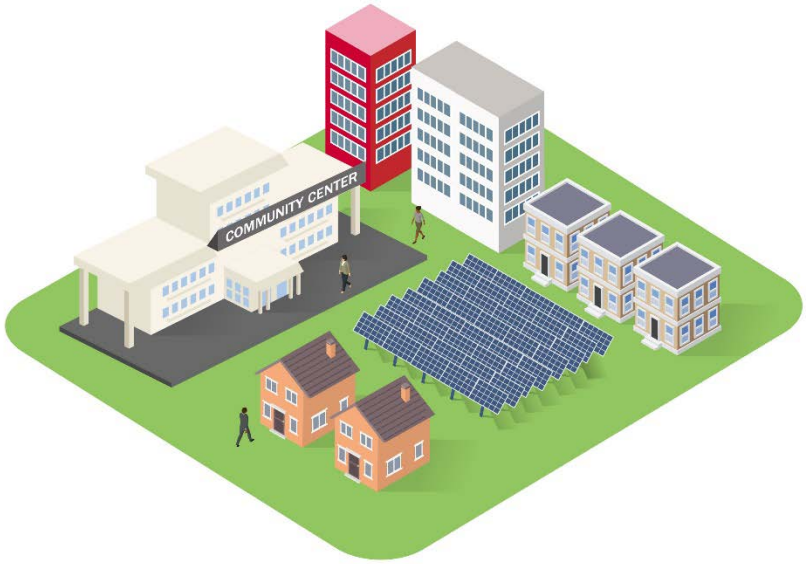

Figure 13. Community solar

Currently, 21 states plus Washington, D.C., have policies that enable community solar through statewide programs or authorization of pilot projects (Figure 14). Sixteen of those states plus Washington, D.C., have some form of LMI-specific provisions (Heeter et al. 2021c). As displayed by Figure 15, community solar projects are currently located in 39 states and Washington, D.C. Although legislation is not mandatory for community solar project development, it can provide benefits. For instance, legislation can improve clarity by requiring the utility to implement on-bill crediting or consolidated billing. It can also increase value by requiring the energy produced to be credited to customers at full retail rates through VNEM. Finally, it can drive development by setting capacity targets.

[11] Due to the variability of community solar programs, participation may come at a premium or lead to savings for subscribers (Heeter et al. 2021b).

Municipal utilities may offer community solar to residents and businesses without access to traditional rooftop PV via municipal utility ownership, community-developed LLCs or special purpose entities, or developer ownership. For more information about community solar for municipalities, as well as ownership and financing mechanisms, see SolSmart's Community Solar Toolkit for Local Governments, the NREL report Lessons Learned: Community Solar for Municipal Utilities, and the NCSP's Municipal Utility Collaborative.

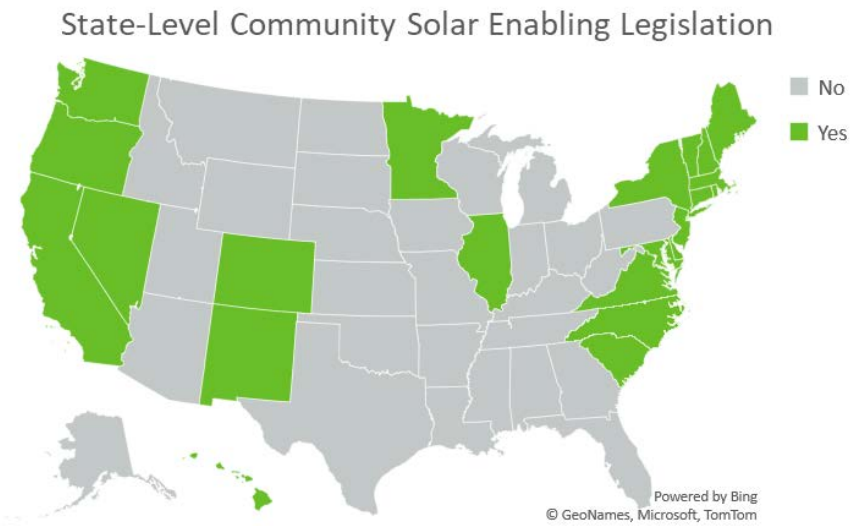

Figure 14. State-level legislation enabling community solar as of 2021

(Heeter et al. 2021b)

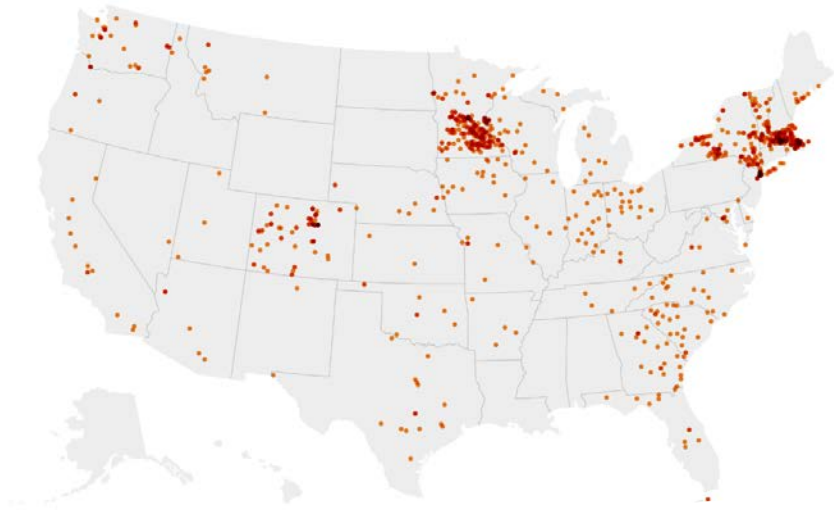

Figure 15. Current community solar projects in the United States as of 2019

(Solstice 2019)

Case Studies

Riverside Community Solar in Fort Collins, Colorado

In 2015, the city of Fort Collins, Colorado, connected with customers of its municipal utility, Fort Collins Utilities (FCU), to determine how to increase local solar energy use. Through this effort, FCU determined that community solar was the best option to provide cost-effective clean energy to the largest number of customers. The first project launched though the program was the Riverside Community Solar Project, a 620-kW array built on a former brownfield site in 2015. Subscriptions were sold out before project construction was complete. For a limited time, FCU offered a rebate of $1 per watt for participants; when paired with the 30% federal investment tax credit (ITC), this rebate reduced the $1,128 panel retail price to $485. Fort Collins has been designated a SolSmart Gold city for its numerous actions to increase solar accessibility and deployment.

For more information, see SolSmart's Community Solar Toolkit for Local Governments, the Fort Collins Community Solar web page, and Fort Collins' SolSmart designation page.

Community Solar in Washington, D.C.

Oxon Run is a 2.65-MW community solar installation on a brownfield site, that provides free power to approximately 750 LMI households in Washington, D.C. Brownfields are typically unproductive, abandoned, or contaminated sites with polluted soils, which can be repurposed for solar installations. To initiate the project, the Washington, D.C. Department of General Services issued an RFP for installation of a community solar array, and the construction contract went to GRID Alternatives. The project is owned by the Washington, D.C. government and is funded by the Department of Energy and Environment.

For more information, see Community Solar at Oxon Run, a presentation about the project, and the RFP that was issued.

Resources

Design and Implementation of Community Solar Programs for Low- and Moderate-Income Customers – This NREL report draws from the literature and from interviews with representatives from LMI solar developers and state LMI community solar programs to provide guidance on LMI community solar design.

Financing Community-Scale Solar – In this report, RMI's community-scale solar program, Shine, and sustainable finance practice area illustrate how established solar financing models can easily be adapted to the community-scale solar market.

IREC Community Solar Basics – This reference guide from IREC gives a brief overview of seven critical program design elements along with accompanying checklists and additional resources to help guide decision makers and stakeholders as they develop community solar programs.

IREC Guiding Principles for Shared Solar Energy Programs – These guiding principles from IREC reflect the benefits of shared renewable energy programs to participants, the renewable energy industry, utilities, and all energy consumers.

Lessons Learned: Community Solar for Municipal Utilities – This summary from NREL discusses specific case studies of municipalities implementing community solar projects, the range of approaches they are taking, and challenges other municipal utilities face in deciding to pursue community solar.

NREL's Community Solar web page – This web page from NREL provides information and resources on community solar, including its current market status, common barriers, overall benefits, design best practices, and pertinent publications.

RE-Powering America's Land Initiative: Community Solar – This EPA report discusses siting community solar on superfund sites, brownfields, landfills, and mine sites, as well as other formerly contaminated sites, under various federal and state cleanup programs.

Shared Renewable Energy for Low- to Moderate-Income Consumers: Policy Guidelines and Model Provisions – This document from IREC provides information and tools for policymakers, regulators, utilities, shared renewable energy developers, program administrators, and others to support the adoption and implementation of shared renewables programs designed to provide tangible benefits to LMI individuals and households.

SolSmart Issue Brief: Expanding Solar Participation Through Community Solar – This SolSmart Issue Brief describes the community solar model and highlights approaches for developing new projects. It discusses why community solar can be beneficial, the ingredients of successful programs, and case studies of successful community solar programs across the country.

SolSmart's Community Solar Toolkit for Local Governments – SolSmart's Community Solar web page provides an overview of community solar, VNEM, community solar ownership models, and implementation tips for local governments.

The National Community Solar Partnership (NCSP) – NCSP is a coalition of community solar stakeholders working to have community solar projects provide 26GW of power and create US$1 billion in bill savings by 2025. Technical assistance is available to members. NCSP also includes partner collaboratives that work together to identify and address common barriers, as well as educational materials. See also the Municipal Utility Collaborative offered through NCSP.

Utility Community Solar Handbook – This handbook from the Solar Electric Power Association provides the utility's perspective on utility-managed community solar program development. The handbook serves as a resource for government officials, regulators, community organizers, solar energy advocates, nonprofits, and interested citizens who want to support or educate their local utility in implementing a new community solar project or improving an existing one.

6.3 Solar for Multifamily Housing

Historically, solar has been difficult to access for those living in multifamily affordable housing (MFAH). Barriers faced by residents of multifamily housing and MFAH include the following:

Residents whose electricity bills are included in their rent or who do not have separate electric meters may be disqualified from subscribing to community solar or making decisions without building owner authorization.

When tenants pay utility bills directly to the utility, MFAH entities or building owners may lack incentives to pursue capital-intensive upgrades that will not translate into utility cost savings for themselves. In other settings, if upgrades are made, the benefits may not reach residents of the building.

MFAH households may not have sufficient capital to afford the upfront cost of a system or community solar subscription, and they may not have adequate income or credit to participate in solar financing programs MFAH residents cannot usually adopt rooftop solar because they do not control roof space.

Programs with individual solar installations or community solar installations that are designed to benefit MFAH households have been deployed at the state and local levels. Solar for MFAH buildings can deliver benefits to residents through pathways such as offsetting electricity use in common areas, offsetting tenant electricity use directly, and supplying credits to utility bills via VNEM (see Appendix A).

Case Studies

Denver Housing Authority Lights the Way for Solar on MFAH

In 2017, the Denver Housing Authority (DHA) planned a 2-MW community solar project. DHA partnered with GRID Alternatives Colorado and Namaste Solar to develop and install the project through Xcel Energy's Solar*Rewards Community Program. The project benefits residents of DHA housing and public housing buildings throughout Denver, including 764 low-income households who receive an estimated savings of 15%–20% on their average monthly utility bills. GRID Alternatives and DHA's resident workforce training program partnered to provide hands-on and classroom solar training to 51 low-income individuals.

For more information, see DHA's Community Solar Project Keeps Housing Affordable, Expanding Solar Availability to the Low-Income Community: Learnings From the Denver Housing Authority, the Solar in Your Community Challenge home page, and Denver's SolSmart designation page.

Santa Fe County Provides Solar to Local MFAH

In 2019, the Santa Fe County Housing Authority (SFCHA) in New Mexico worked with the International Center for Appropriate and Sustainable Technology (ICAST) to increase access to solar for local low-income MFAH residents. At the time, community solar was not enabled in New Mexico, making it difficult to aggregate the demand from each of the individually metered units into one solar array. SFCHA and ICAST developed a plan to provide 220 kW of rooftop PV through individual solar system installations for individual apartments. These individual installations benefited residents of 196 row homes and multiplexes located at three separate

locations across the county. ICAST helped SFCHA fund the program through energy performance contracting financing, allowing tenants to receive the installations at no cost.

For more information, see Access to Solar for Low-Income Residents of Multifamily Affordable Housing, ICAST Performs Income-Qualified Solar Install in Santa Fe County, and Santa Fe County's SolSmart designation page.

Resources

California's Solar on Multifamily Affordable Housing Program – California implemented the Solar on Multifamily Affordable Housing program to provide financial incentives for installing PV systems on MFAH and to deliver clean power and energy bill credits to California's affordable housing residents.

Energy Equity for Renters – This initiative from the ACEEE offers many resources, including a guide for local governments, energy burden research, building performance standards, and more.

Expanding Solar Access: Pathways for Multifamily Housing – This guide from IREC outlines two potential paths to enable solar access for renters, multifamily housing residents, and LMI communities. The first is on-site shared solar, which allows energy credits from a single solar system to be shared virtually among multiple tenant accounts. The second is off-site/remote shared solar, which allows multiple dispersed customers to share the economic benefits of a single renewable energy system and receive bill credits for electricity generated by that common system.

Getting Started: Solar for Multi-Family Affordable –This document from GRID Alternatives lists factors to consider while examining the feasibility of solar for MFAH properties.

Multifamily Green Retrofit Toolkit – This toolkit from the U.S. Department of Housing and Urban Development provides guidance for the various stages of upgrading multifamily properties.

National Community Solar Partnership: Multifamily Affordable Housing Collaborative – This NCSP collaborative is made up of stakeholders who are working together to expand access to community-based solar to MFAH buildings.

Renewable Energy Toolkit for Affordable Housing – This toolkit, from the Department of Housing and Urban Development's Office of Community Planning and Development, provides a step-by-step guide to integrating renewable energy into affordable housing projects in a way that is efficient, cost-effective, and impactful.

Unlocking Solar for Low- and Moderate-Income Residents: A Matrix of Financing Options by Resident, Provider, and Housing Type – This NREL report identifies the most promising strategies policymakers might consider using to finance PV for LMI customers across three housing types: single-family, multifamily, and manufactured housing.

6.4 Innovative Solar Deployment Opportunities

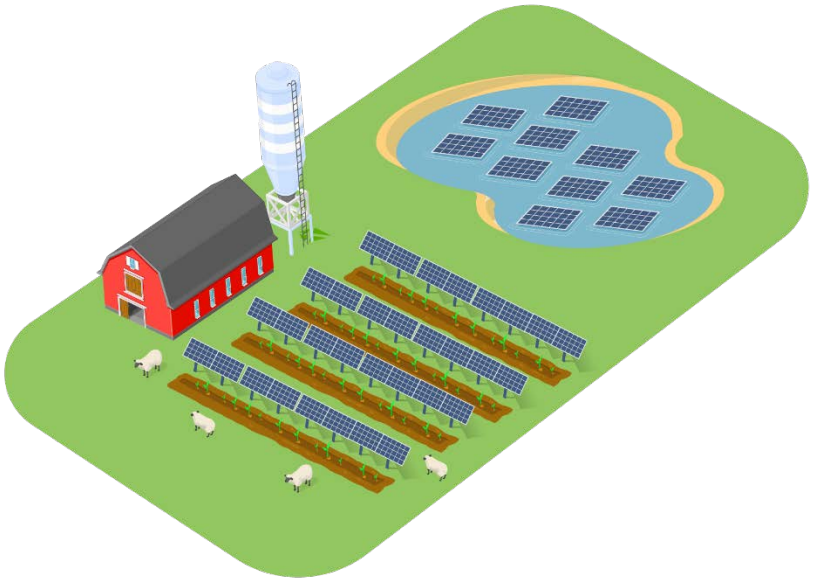

Figure 16. Innovative solar deployment technologies

Solar on Brownfields

A brownfield is a former industrial or commercial site that may be contaminated with pollutants, such as an old landfill, an abandoned gas station, or a decommissioned refinery. Landfills and other contaminated sites cover approximately 15 million acres of the United States (Kiatreungwattana et al. 2013). Former industrial sites are typically large, flat, and unshaded; have electricity and road infrastructure; and are located near areas with high energy demand—all features that are ideal for a PV system. Siting solar on brownfields is more expensive than on non-brownfield sites and may entail additional risks (e.g., environmental remediation costs, changes in regulations).

TIP

However, the benefits of brownfield installations can include the following:

- Avoided land-use conflicts
- Lower costs for the land itself
- Profit from sites that previously only had maintenance costs
- Profit from sites that may have environmental conditions not suited for commercial or residential redevelopment
- Local job opportunities
- Revitalization of unused land within communities.

For more about benefits, see RE-Powering America's Land Initiative: Benefits Matrix from the EPA.

Government programs to encourage the use of brownfields for PV include the EPA's RE-Powering America's Land Initiative, which provides tools, outreach, guidance, and technical assistance. Financial incentives may also be available. For example, the Rhode Island Commerce Renewable Energy Fund Brownfields Solar PV program provided $1 million in grants to solar projects on brownfields in 2020.

Agrivoltaics

Co-located agriculture and PV, or "agrivoltaics," can incorporate crop production, pollinator habitat, or livestock grazing beneath solar panels, providing benefits to both the agriculture and solar energy. Farmers can diversify their income with renewable energy generation. Water savings and increased soil water retention are possible because of shading from the PV panels. Cooler PV panels provide higher efficiencies leading to more generation. Yields can be higher for some crop types, particularly in the dry, Southwest region of the U.S. (Barron-Gafford et al. 2019). Native vegetation provides a habitat for pollinators (bees, birds, and other insects), and it requires less maintenance than gravel or turf grass. Animal grazing decreases operations and maintenance costs by reducing the need for grass mowing. Co-locating multiple land uses reduces land-use conflicts.

Local legislation could be considered to encourage favorable permitting or zoning for these practices. As of 2021, 15 states have pollinator solar standards which encourage habitat underneath ground-mounted solar systems—including planting diverse pollinator-friendly and/or native plants, mowing less frequently, hosting bees, and refraining from using insecticides on-site. Fresh Energy has a published list of existing Pollinator-Friendly Solar Scorecards.

See the American Solar Grazing Association website for information on livestock grazing and solar; NREL's Innovative Solar Practices Integrated with Rural Economies and Ecosystems (InSPIRE) project for information on low-impact solar development opportunities, including agrivoltaics; and CESA's State Pollinator-Friendly Solar Initiatives for information on the different state policies on pollinator-friendly solar projects.

Electric Vehicle Charging Infrastructure With Solar

Along with the solar market, the electric vehicle (EV) market is also growing in the United States. EVs can impact the electric grid by increasing and shifting demand, and they have the potential to provide grid benefits as mobile energy storage units through vehicle-to-grid programs. EV charging infrastructure can be combined with solar generation with the help of managed charging (adjusting the time and rate of charging) or solar synchronized managed charging (charging vehicles when solar is producing power) (Ross et al. 2020). The State and Local Planning for Energy (SLOPE) tool has transportation data visualizations that can help communities understand current and future vehicle electrification scenarios.

For more information see Solar Power + Electric Vehicle Charging or Navigating Options for Transportation Electrification and Solar charging.

Floating Photovoltaics

Floating photovoltaic (FPV) systems are sited primarily on artificial water bodies, such as reservoirs or water treatment impoundments, with solar panels affixed to plastic floats or pontoons that lock together to create a raft. Power cables connect the panels to equipment and transmission lines on shore. FPV systems can be standalone or hybridized with a hydropower plant, though hybridized systems are not yet common in the United States (Figure 17).

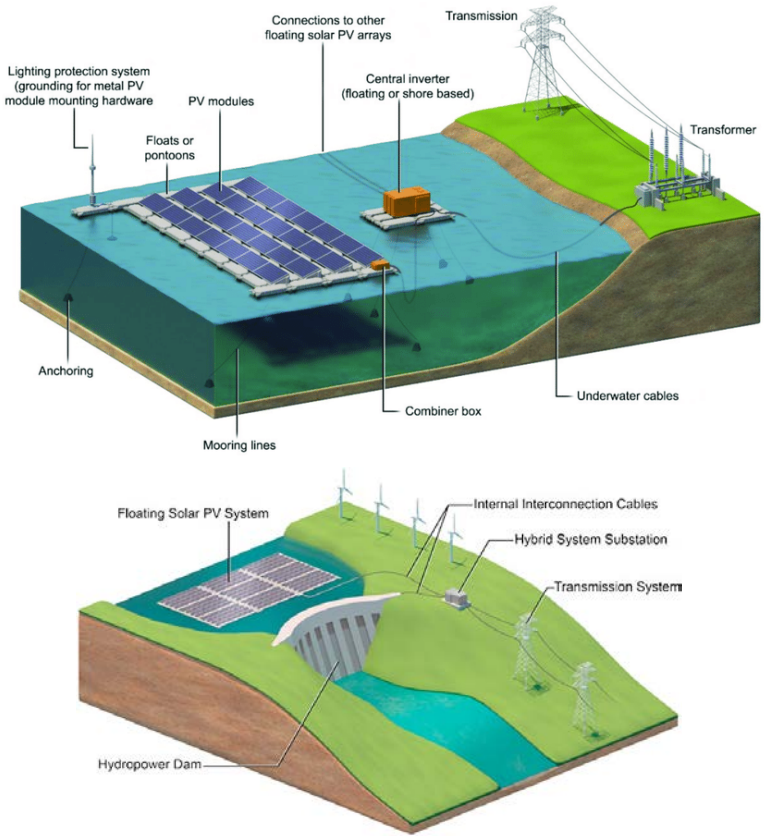

Figure 17. Schematics of a standalone FPV system (top) and a hybrid hydropower FPV system (bottom)

(Lee et al. 2020)

FPV systems are typically more expensive than ground-mounted systems, but they can avoid land-use conflicts, reduce land acquisition and site preparation costs, improve PV performance due to reduced panel shading and cooling by the water, utilize potentially underused space, and provide power system and cost benefits when co-located with hydropower.

For more information, see International Applications for Floating Solar Photovoltaics.

Case Studies

Solar Array on a Landfill in Easthampton, Massachusetts

Easthampton, Massachusetts, installed 2.3 MW of solar on 16 acres of the Oliver Street Landfill, generating 2,800 MWh annually. The City Council changed zoning laws to allow for the project, which faced more technical challenges than a typical solar installation. The project was awarded to Borrego Solar Systems, Inc. after a request for qualifications process. Borrego owns the system and sells the city electricity at a lower rate than it previously paid.

For more information, see Letting the Sunshine In and Powering Up Landfill.

Floating Solar in Sayreville, New Jersey

Lacking available land, Sayreville used an FPV system to offset electricity use at the local water treatment facilities, Public Works Building, and Borough Hall. The 4.4-MW array of 12,700 panels on a pretreatment water retention pond produces enough electricity to offset 100% of the water treatment facility energy use. Because of permitting restrictions, the system was constructed differently than a typical system. Most FPV systems are anchored to the waterbed, but local permitting rules required projects to be secured to the shore.

For more information, see New Jersey Town Keeps Its Water Clean With the Country's Largest Floating Solar System and New Jersey Installs Largest Floating Solar System in North America.

Houston Brownfield Solar Project

The city of Houston approved a lease agreement with Sunnyside Energy, LLC for the Sunnyside Solar Project, which will convert a closed 240-acre landfill into a solar installation. This project resulted from the C40 Reinventing Cities competition, which involved 14 cities across the world identifying brownfields that could be redeveloped. The Houston team created a vision to transform the closed landfill to include a solar farm, an agricultural hub and training center, a community solar project, and more. The project proposes 70 MW of panels that will generate electricity for 12,000 homes, with plans to provide discounts for low-income residents.

The project has been included in the Sunnyside Complete Communities Action Plan, which aims to build a more resilient city and ensure that all community members have access to quality services and amenities. The Sunnyside Solar Project is expected to expand local economic development via job training and agricultural opportunities. In addition, the project will improve local environmental health, as the landfill cover and cap will be restored.

For more information, visit City Selects Firm Proposing Solar Energy Farm at Former Sunnyside Landfill, and Sunnyside Landfill.

Resources

AgriSolar Clearinghouse – The AgriSolar Clearinghouse is an information-sharing, relationship-building, public communications hub for all things agrisolar developed by the National Center for Appropriate Technology.

Beneath Solar Panels, the Seeds of Opportunities Sprout and Benefits of Agrivoltaics Across the Food-Energy-Water Nexus – These articles from NREL discuss agrivoltaics and the benefits for food, water, and energy.

Best Practices for Siting Solar Photovoltaics on Municipal Solid Waste Landfills – This guide from NREL outlines best practices for siting PV on municipal solid waste landfills.

Colorado Agrivoltaic Learning Center – This organization in Longmont, Colorado, studies different types of agrivoltaics, including pollinator-friendly, grazing, and crop production agrivoltaics. The organization has the largest agrivoltaics research site in the United States.

Community Planning Guide for Electric Vehicles – This handbook from North Carolina Advanced Energy Corporation summarizes EVs, charging, and planning for EVs.

Floating Photovoltaic Systems: Assessing the Technical Potential of Photovoltaic Systems on Man-Made Water Bodies in the Continental United States – This report from NREL found that 24,419 human-made water bodies in the United States are suitable for FPV development. The report studies the impacts of FPV on land conservation, utility costs, and evaporation losses. The Supporting Information provides information on the benefits that FPV can provide for each state.

Handbook on Siting Renewable Energy Projects While Addressing Environmental Issues – This handbook from the EPA's RE-Powering Initiative provides tools for those interested in building renewable energy projects on potentially contaminated sites.

Navigating Options for Transportation Electrification and Solar Charging – This report from the Montana Solar Energy Innovation Network Team assists communities that are considering investing in electric transportation. It includes background information, costs and benefits, and information on EVs plus renewable energy.

NYSERDA Solar Guidebook – This guidebook includes a "Municipal Solar Procurement Toolkit," which provides step-by step instructions on how municipalities can lease underutilized land such as landfills and brownfields for solar.

RE-Powering America's Land Initiative: Community Solar – This EPA report discusses siting community solar on superfund sites, brownfields, landfills, and mine sites, as well as other formerly contaminated sites, under various federal and state cleanup programs.

Solar Power + Electric Vehicle Charging: Capturing Synergies in Minnesota – This report from the Great Plains Institute discusses market transformation opportunities and barriers for solar plus EVs in Minnesota. Lessons learned can be applied in other jurisdictions.

State Pollinator-Friendly Solar Initiatives – This report from CESA provides an overview of state efforts to encourage solar PV development in a manner that is beneficial to pollinators.

The Road Ahead: Planning for Electric Vehicles by Managing Grid Interactions – This report from the National Governors Association discusses transportation electrification and the steps needed to make this transition.

Appendix A: Assessing the State and Federal Solar Policy Environment

Solar- and renewable energy-focused policy is one of the primary factors contributing to the increased deployment of solar over the past 10 years, and many of these policies have been implemented at the state or federal level. Identifying the regulatory, policy, and incentive frameworks that affect local solar energy adoption will help community leaders accurately assess the solar policy landscape in their area. This appendix reviews critical questions regarding state and federal policies that can impact local solar planning.

For more information, see Low-Income Solar Policy Guide, DSIRE: Database of State Incentives for Renewables and Efficiency, SolSmart's Toolkit for Local Governments page on Federal and State Context, and the topic-specific resources provided in each section of this appendix. For state-specific information on clean energy policies, visit the State Policy Opportunity Tracker (SPOT) for Clean Energy.

Is there a state policy requiring clean energy investment?

Renewable Portfolio Standards

Renewable portfolio standards (RPS), sometimes called renewable energy standards or clean energy standards, have had a significant impact on the renewable energy market at the state level. Roughly half of all renewable energy generation and capacity from 2000–2020 is associated with state RPS requirements (Barbose 2021). An RPS requires utility companies to source a certain amount of the energy they generate or sell from renewable sources, including solar. Currently, 30 states and Washington, D.C., have implemented an RPS, and another eight states have renewable portfolio goals (Figure 18). Although local communities are not required to meet an RPS, these policies influence the solar energy market and price.

These policies can go further by requiring carve-outs for specific technologies. Solar-specific carve-outs encourage solar development by requiring utilities to acquire a certain amount of solar energy.

For more information, see NREL's RPS web page and SolSmart's Toolkit for Local Governments page on Federal and State Context.

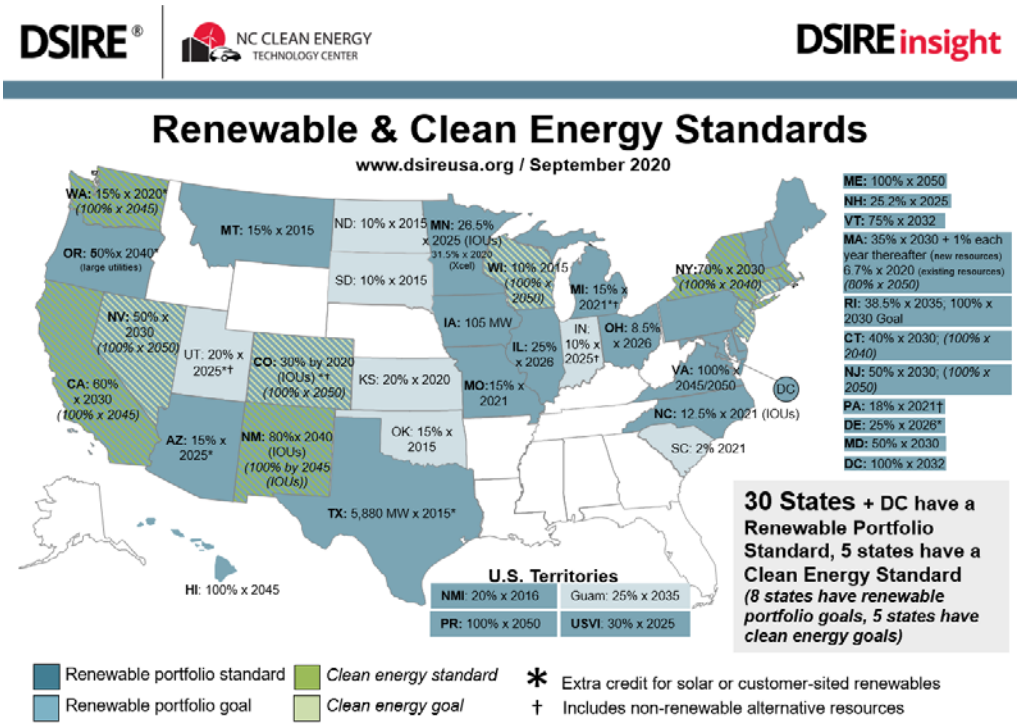

Figure 18. Renewable and clean energy standards map

(DSIRE 2020)

Do state policies ensure that a solar system's owners/hosts are compensated for the energy they produce?

Net Metering and Other Bill Credit Mechanisms

Net energy metering (NEM) (often called simply "net metering") is a billing method that credits solar system owners for electricity exported onto the grid, and is the most popular form of compensating distributed generation owners for the energy they produce. Under the simplest form of net metering, a utility customer's billing meter runs backward as solar electricity is generated and exported to the electricity grid, and it runs forward as electricity is consumed from the grid. At the end of a billing period, the customer receives a bill for net electricity, which is the amount of electricity consumed minus the amount of electricity produced and exported by the utility customer's PV system. This policy allows PV system owners to offset electricity purchases from the utility with every kWh of electricity their PV system produces. The states offering net metering are depicted in Figure 19.

Under VNEM, dispersed individual ratepayers are credited for electricity produced by an off-site solar array. Participants in a community solar program can receive VNEM credits in exchange for their financial contribution to a solar project. This contribution can take the form of an upfront purchase of PV panels or a monthly charge on the customer's utility bill. As the community solar system generates electricity—which is typically fed directly into the grid—the

participants get a utility bill credit or some other form of compensation for the electricity their share of the system produces.

In recent years, some states have moved away from traditional net metering and have begun experimenting with alternative compensation options. These alternatives may allow for a more granular calculation of the costs and benefits associated with distributed generation to compensate stakeholders accordingly. Advances in communications and smart grid technologies also enable more refined calculations of distributed generation value (NREL 2021c).

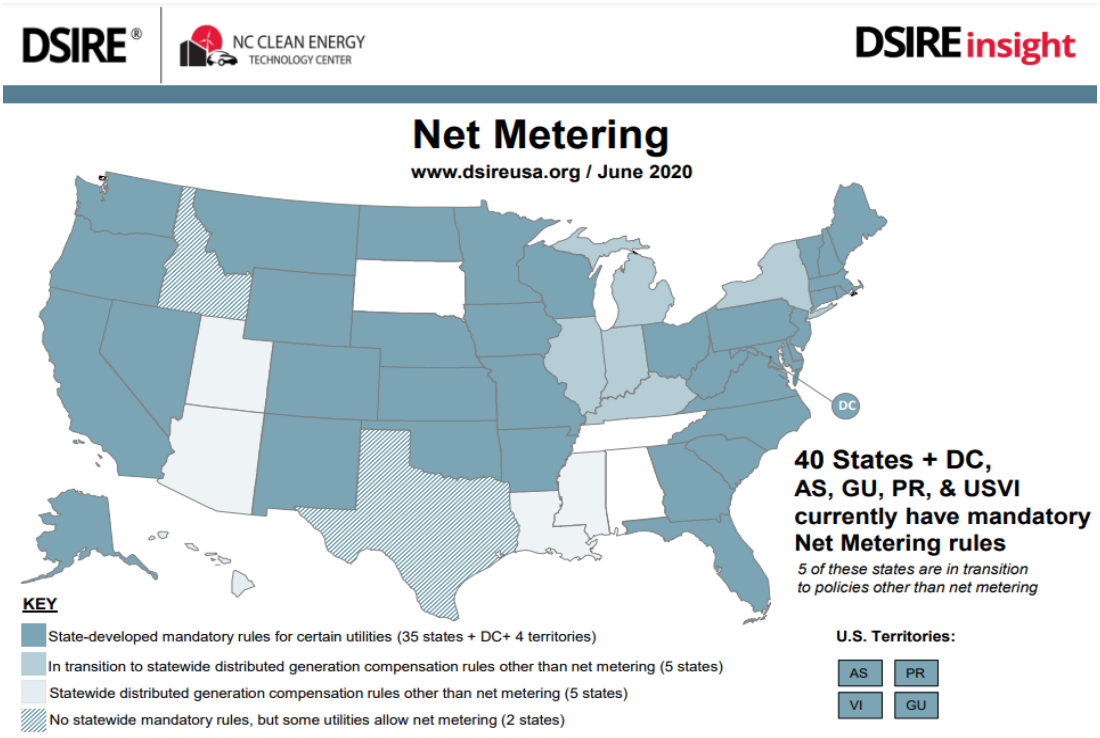

Figure 19. Net metering policy map

(DSIRE 2020)

For more information, see NREL's Net Metering web page or SolSmart's Toolkit for Local Governments page on Federal and State Context, as well as the Low-Income Solar Policy Guide.

Net Metering Rate Design

Net metering customer compensation varies by state. Many states require utilities to compensate customers at the full retail rate for electricity, whereas other states compensate at a different level based on the wholesale rate. Utilities often make the case that net metering unfairly exempts distributed solar customers from paying their fair share of costs to support the grid, leading to cost shifting of grid maintenance or upgrade expenses. However, as stated in SolSmart's Toolkit for Local Governments, "distributed solar also provides many benefits to the grid, which can include deferring the need for investment in new capacity, creating local jobs, reducing greenhouse gas emissions, and generating energy at the local level" (SolSmart 2021).

For more information about rate design, see SolSmart's Toolkit for Local Governments page on Federal and State Context or NREL's Net Metering web page.

Feed-In Tariff (FIT)

A FIT is a renewable energy policy that typically offers renewable energy project owners a guaranteed payment for electricity produced by their renewable energy system over a fixed period, usually 15 to 20 years. FITs are significantly more popular outside of the United States but have been offered in a few instances domestically.

What policies or programs provide incentives or financing mechanisms to reduce the upfront costs of solar?

This section includes information on incentives not covered in the body of this guidebook. For more information on solarize campaigns, PACE financing, and Green Banks, see Section 2.3.

Federal Tax Credits

The main incentives currently available on the federal level are the investment tax credit (ITC), the and the production tax credit (PTC). The ITC is available to residential (under Section 25D) and commercial and utility (under Section 48) renewable energy projects and can be claimed against tax liability as a credit for a system installed. The PTC is a per-kWh tax credit for the project owner (who must be a taxpayer) when the electricity is sold to an unrelated person during the taxable year. The PTC can be claimed over a 10-year period. The ITC was enacted in 2006 and has been a significant contributor to solar growth. The PTC was first enacted in 1992, but has been a less significant driver of solar development. The ITC and PTC were both extended by the Taxpayer Certainty and Disaster Tax Relief Act at the end of 2020 (116th Congress 2021).

For more information, see DOE's Homeowner's Guide to the Federal Tax Credit for Solar Photovoltaics and DSIRE's ITC, Residential Renewable Tax Credit , and PTC web pages.

State Tax Credits and Incentives

Some states offer additional incentive programs that complement the federal ITC. Many state-level incentives come in the form of tax credits that can be deducted from the state tax burden. Other state-level incentives include cash rebates, property tax exemptions as compensation for electricity generated, performance-based incentives, and earnings from selling the solar renewable energy certificates (SRECs) generated by a solar system. The availability and level of incentives can vary widely by state.

For more information on specific state programs, see DSIRE's comprehensive list of solar incentives by state.

Production-Based Incentives and Renewable Energy Certificates

Production-based incentives (PBIs) are cash payments that are distributed to project owners over several years based on the amount of energy a system produces. Renewable energy certificates (RECs) are a common vehicle for PBIs. RECs are equal to 1 MWh of renewable energy and can

be applied toward meeting RPS goals and carve-outs. When applied to solar, they are known as SRECs. If an RPS has a solar target, regulated electric utilities must either own a solar installation or purchase SRECs from retail customers who own their solar installations to meet the solar target. SRECs can then be applied to meet a state-specific RPS or solar carve-outs within a state-specific RPS. The price of an SREC varies by state, as well as by supply and demand of the local market. As of 2020, states with SREC markets included California, Connecticut, Delaware, Illinois, Massachusetts, Maryland, New Jersey, North Carolina, Ohio, and Pennsylvania, plus the District of Columbia, though many other states participate in REC markets without a carve-out for solar (SolSmart 2021).

For more information, see SolSmart's Toolkit for Local Governments page on Federal and State Context and the Low-Income Solar Policy Guide. Read more about SRECs on DSIRE.

For more information about specific state-level tax credits and incentive programs, see DSIRE's Program Database.

LIHEAP and WAP Funding

The U.S. Department of Health and Human Services' Low Income Home Energy Assistance Program (LIHEAP) assists low-income households with their heating and cooling energy costs, bill payment assistance, energy crisis assistance, and weatherization and energy-related home repairs. It is administered by states. LIHEAP funding can also be used to fund solar systems on low-income homes. There are only a few examples of using LIHEAP funding for low-income solar adoption to date, for example in Colorado. However, there has been interest from other states in using this model (Cook and Shah 2018). The LIHEAP program has also been used as a proxy to identify low-income households for solar program eligibility.

DOE's Weatherization Assistance Program (WAP) reduces energy costs for low-income households by increasing the energy efficiency of their homes. WAP funding can also be used to fund a solar system for low-income households. A state interested in integrating solar into WAP must obtain approval from DOE to include the technology in its program, which requires demonstrating the effectiveness of solar in generating savings.[12] States such as Colorado and Minnesota have used this funding source for PV for income-qualifying residents (Cook and Shah 2018; State of Minnesota Department of Commerce 2020).

For more information, see NREL's Low- and Moderate-Income Solar Policy Basics page, the Low-Income Solar Policy Guide, and NREL's report on Reducing Energy Burden With Solar: Colorado's Strategy and Roadmap for States.

[12] The Savings to Investment Ratio Calculator for Renewables tool from NREL explores the affordability of solar using a "Savings to Investment Ratio," the metric that captures the ability to recover one's investment in solar.

USDA Rural Energy for America Program Grants

Agricultural producers and small businesses are eligible for Rural Energy for America Program (REAP) grants through the U.S. Department of Agriculture (USDA). These grants provide funds for up to 25% of the cost of a proposed renewable energy system project, including PV.

For more information, see USDA's Rural Energy for America Program Renewable Energy Systems & Energy Efficiency Improvement Guaranteed Loans & Grants and DSIRE's REAP page.

Cash Incentives

Direct cash incentives give consumers cash back for a qualified solar installation and can come from local, utility, state, or federal sources (or from private sources, such as nonprofits or foundations). Direct incentives include rebates, grants, expected performance rebates, and PBIs that complement other incentives, such as tax credits. Rebates are cash incentives issued to a purchaser after the system has been installed. Grants are funds awarded for solar installation projects that may be distributed before installation to cover project costs. Expected performance rebates are cash incentives based on solar system capacity as well as system rating, location, tilt, orientation, and shading. Expected performance rebates can be distributed in a lump sum but are calculated based on the expected energy output of the system; they do not commit installers and system owners to maintain system generation, as do PBIs, which are paid overtime based on actual performance.

Policies and Incentives Specific to LMI Populations

California, Colorado, Massachusetts, Minnesota, New York, Oregon, and other states have developed policies to extend solar access to LMI populations. Some of these states have gone further, implementing financing mechanisms designed to make solar more accessible to LMI communities, such as direct incentives and alternative loan programs (e.g., loan loss reserve programs and revised underwriting criteria for loans).

For more information, see NREL's Low- and Moderate-Income Solar Policy Basics page, CESA's Solar With Justice: Strategies for Powering Up Under-Resourced Communities and Growing an Inclusive Solar Market, and the Low-Income Solar Policy Guide. To identify low-income-specific incentives and programs by state, see CESA's Directory of State Low- and Moderate-Income Clean Energy Programs.

Appendix B: List of All Resources

3 Hurdles to Racial Justice in Clean Energy – And 3 Ways U.S. Cities Can Overcome Them – This article from the World Resources Institute addresses three specific barriers to racial justice in the implementation of renewable energy, as well as local-level solutions help overcome these barriers.

A Guidebook on Equitable Clean Energy Program Design for Local Governments and Partners – This guide from the Cadmus Group helps local governments design equitable clean energy programs.

A Guide to Zero Energy and Zero Energy Ready K–12 Schools – This guide from NREL outlined outlines the steps and documents the process of creating a zero-energy school and can provide a strong foundation for future zero energy school projects.

Achieving Cooperative Community Equitable Solar Sources (ACCESS) – This project from the National Rural Electric Cooperative Association shares research on how to make solar energy affordable for LMI communities. This page has tools and resources on equitable and affordable solar deployment.

Advice for States on 100% Clean Energy Planning – This resource was developed by CESA to assist states (and other entities) that have 100% clean energy goals by providing knowledge-sharing activities and analysis so that together they can address program challenges and opportunities.

Affordable and Accessible Solar for All: Barriers, Solutions, and On-Site Adoption Potential – This NREL report reviews the market and regulatory barriers to low-income solar access and affordability, and summarizes current solutions to those challenges.

AgriSolar Clearinghouse – The AgriSolar Clearinghouse is an information-sharing, relationship-building, public communications hub for all things agrisolar developed by the National Center for Appropriate Technology.

American Green Bank Consortium – This membership organization helps Green Banks, capital providers, developers, and other clean energy supporters work together to expand and accelerate innovative clean energy investment across the United States.

Apprenticeship Finder – This resource from the U.S. Department of Labor provides details on apprenticeship programs and job listings by occupation or keyword and location.

Are You Solar Ready? – This article from the American Planning Association discusses seven steps communities can take to prepare for large-scale solar development.

Becoming a Solar-Ready Community – This guide, developed by the state of Michigan for local governments, provides a 10-step process to adopting solar-ready policies at the local level.

Although the guide was developed for Michigan communities, these steps can be applied by jurisdictions across the country.

Beneath Solar Panels, the Seeds of Opportunities Sprout and Benefits of Agrivoltaics Across the Food-Energy-Water Nexus – These articles from NREL discuss agrivoltaics and the benefits for food, water, and energy.

BETTER: Building Efficiency Targeting Tool for Energy Retrofits – BETTER is a software toolkit developed in partnership with DOE and LBNL that enables building operators to identify the most cost-saving energy efficiency measures in buildings and portfolios using readily available building and energy data.

Better Buildings Solution Center – Through the Better Buildings Initiative, DOE partners with leaders in the public and private sectors to make the nation's homes, commercial buildings, and industrial plants more energy-efficient. Better Buildings accelerates investment and facilitates sharing of successful best practices.

Best Practices for Siting Solar Photovoltaics on Municipal Solid Waste Landfills – This guide from NREL outlines best practices for siting PV on municipal solid waste landfills.

Best Practices in Zoning for Solar – This blog post from NREL discusses best practices for zoning for solar and provides additional resources.

Brighter Future How-To Guide – This guide from Generation180 helps schools get started with solar to receive benefits such as financial savings, educational opportunities for students, energy resilience, and healthier families and communities.

Brighter Future Report 2020 – This study on solar in U.S. schools from Generation180 discusses how schools can implement solar into their curricula and job training, and includes new data and trends on solar uptake at schools nationwide, as well as case studies for specific school districts.

Brighter Future: A Study on Solar in U.S. Schools – This study from Generation180 includes data and trends on solar uptake in schools.

California's Solar on Multifamily Affordable Housing Program – California implemented the Solar on Multifamily Affordable Housing program to provide financial incentives for installing PV systems on MFAH and to deliver clean power and energy bill credits to California's affordable housing residents.

Cities Renewables Accelerator – The American Cities Climate Challenge is a program from Bloomberg Philanthropies to help cities meet carbon-reduction goals. The Cities Renewables Accelerator, which is part of this program, supports cities with procurement. The program also offers technical assistance on economic inclusion to leverage procurement and other activities to support good local jobs.

Clean Energy Equity Examples – This resource from the Low-Income Solar Policy Guide is a list of clean energy equity examples at the state and city level, which includes equity advisory, oversight and working groups.

CELICA Toolkit: Clean Energy Solutions for Low-Income Communities – This toolkit from DOE's Better Buildings Initiative provides tools, resources, and models for developing low-income energy efficiency and renewable energy programs.

Coalition for Green Capital Resource Library – For a deeper dive into Green Banks, this resource library from Coalition for Green Capital provides materials on proposed and operating Green Banks in the United States and internationally, as well as other educational information.

Colleges and Universities – This map from DOE provides information on higher education learning opportunities in energy.

Colorado Agrivoltaic Learning Center – This organization in Longmont, Colorado, studies different types of agrivoltaics, including pollinator-friendly, grazing, and crop production agrivoltaics. The organization has the largest agrivoltaics research site in the United States.

Community Choice Aggregation Explained in Less Than 5 Minutes – This primer from Solstice discusses the pros and cons of CCA and the relationship between CCA and community solar.

Community Choice Aggregation: Challenges, Opportunities, and Impacts on Renewable Energy Markets – This report from NREL summarizes the status of CCA in the United States, impacts of CCA on renewable energy markets, and challenges.

Community Outreach and Solar Equity: A Guide for States on Collaborating With Community-Based Organizations – This guide from CESA is aimed at state energy agencies that are looking to strengthen relationships with local under-resourced communities or that are beginning to engage in energy justice work. The guide is a collection of best practices, ideas, and principles that provide states with a foundation for building equitable relationships with community-based organizations (CBOs) and working with them on solar development.

Community Planning Guide for Electric Vehicles – This handbook from North Carolina Advanced Energy Corporation summarizes EVs, charging, and planning for EVs.

Design and Implementation of Community Solar Programs for Low- and Moderate-Income Customers – This NREL report draws from the literature and from interviews with representatives from LMI solar developers and state LMI community solar programs to provide guidance on LMI community solar design.

Designing Community Solar Programs That Promote Racial and Economic Equity – This white paper from the Institute for Local Self-Reliance provides guidance for creating community solar programs that promote racial and economic equity. It defines what makes a community solar program equitable and states objectives that community solar programs striving to be equitable

can pursue, including objectives related to program structure, consumer participation, compensation, and other policy areas.

Directory of State Low- and Moderate-Income Clean Energy Programs – This directory from CESA describes state clean energy programs for LMI residents and communities.

Disadvantaged Communities – Single-Family Solar Homes Program: 2020 Marketing, Education and Outreach Plan – The Single-Family Solar Homes program is administered by the nonprofit GRID Alternatives in California. This document describes the marketing and outreach plan for the program, identifying target audiences and approaches.

Diverse Suppliers Database – This database of companies with diverse ownership was developed at the direction of SEIA's Diversity, Equity, Inclusion, and Justice Leadership Council as part of an effort to support and promote diverse businesses in the industry.

Diversity Best Practices Guide for the Solar Industry – This guide from SEIA and the Solar Foundation outlines best practices for enhancing diversity and inclusion in solar industry companies.

EJSCREEN: Environmental Justice Screening and Mapping Tool – This tool from the EPA is an environmental justice mapping and screening tool that provides EPA with a nationally consistent dataset and approach for combining environmental and demographic indicators.

Energy Efficiency and Distributed Generation for Resilience: Withstanding Grid Outages for Less – This DOE report describes how energy efficiency can be integrated into planning and includes real-world examples.

Energy Equity for Renters – This initiative from the ACEEE offers many resources, including a guide for local governments, energy burden research, building performance standards, and more.

Energy Resilience in the Public Sector – This landing page from DOE offers resources and tools for state and local governments on energy and resilience.

Energy Storage Implementation Guide – This guide from the Energy Storage Integration Council covers the complete life cycle of an energy storage project.

Energy Transitions Playbook – This guidebook from DOE's Energy Transitions Initiative provides a seven-phase process for a community-driven transition to a resilient, clean energy system. The Playbook includes worksheets, templates, and case studies to assist communities with planning at any phase .This resources also includes a stakeholder matrix and stakeholder mapping template to help identify and categorize stakeholders for creating an advisory committee or task force.

Equitable Clean Energy Planning – This series of webinars from the World Resources Institute guides local government staff through equity-centered, scenario-based planning for community-level energy policy.

Expanding Solar Access: Pathways for Multifamily Housing – This guide from the Interstate Renewable Energy Council (IREC) outlines two potential paths to enable solar access for renters, multifamily residents, and LMI communities. The first is on-site shared solar, which allows energy credits from a single solar system to be shared virtually among multiple tenant accounts. The second is off-site/remote shared solar, which allows multiple dispersed customers to share the economic benefits of a single renewable energy system and receive bill credits for electricity generated by that common system.

Explanation of Certain Key Terms in the PPA – This interactive tool from NREL shows a mock PPA and provides definitions for terms within it.

Financing Community-Scale Solar – In this report, RMI's community-scale solar program, Shine, and sustainable finance practice area illustrate how established solar financing models can easily be adapted to the community-scale solar market.

Floating Photovoltaic Systems: Assessing the Technical Potential of Photovoltaic Systems on Man-Made Water Bodies in the Continental United States – This report from NREL found that 24,419 human-made water bodies in the United States are suitable for FPV development. The report studies the impacts of FPV on land conservation, utility costs, and evaporation losses. The Supporting Information provides information on the benefits that FPV can provide for each state.

Getting Started: Solar for Multi-Family Affordable –This document from GRID Alternatives lists factors to consider while examining the feasibility of solar for MFAH properties.

Green Bank Network – The Green Bank Network is a membership organization that was formed to foster collaboration and knowledge exchange among existing Green Banks, enabling them to share best practices and lessons learned.

Greenlink Equity Map (GEM) – GEM is an online map to help users visualize equity-related issues. It includes data on income, energy burden, water burden, internet access, and more.

GRID Alternatives Solar Futures – GRID Alternatives created the Solar Futures program to provide classroom and hands-on solar education to K–14 students, with a focus on high school juniors and seniors, to illuminate career pathways in the solar industry.

Guidelines for Community Commitments to 100% Renewable Energy – This document from the Sierra Club provides guidelines for creating an equitable and just transition to 100% clean, renewable energy, and includes options for integrating solar into these goals.

Guidelines for Residential PACE Financing Programs – These DOE guidelines outline best practices that can help state and local governments, PACE program administrators, contractors, and other partners develop and implement programs and improvements that effectively deliver home energy and related upgrades.

GW Solar Institute Education Center – The George Washington University Solar Institute Education Center curates information that is accessible to a wide range of audiences.

Handbook on Siting Renewable Energy Projects While Addressing Environmental Issues – This handbook from the EPA's RE-Powering Initiative provides tools for those interested in building renewable energy projects on potentially contaminated sites.

High-Road Workforce Guide for City Climate Action – This guide provides a step-by-step manual for fostering union engagement, building a workforce collaborative, and undertaking workforce planning activities in a way that supports good-quality jobs and accessible pathways for underrepresented and disadvantaged workers.

Homeowner's Guide to Going Solar – This guide from DOE can help homeowners make solar-related decisions. It is also available in Spanish.

How Distributed Energy Resources Can Improve Resilience in Public Buildings – This DOE report provides three case studies about distributed energy resources in public buildings, as well as a step-by-step guide for how to conduct analysis using two publicly available tools, REopt Lite and the Distributed Energy Resources Customer Adoption Model (DER-CAM).

How Local Governments Can Buy Renewable Energy and Support Market Development – This webinar from SolSmart covers strategies that local governments can consider to procure renewable energy. It covers the impacts of the regulatory landscape.

How To Set Renewable Electricity Goals That Align With Community Priorities – This article from the Great Plains Institute discusses how a community can set electricity goals. It has a solar calculator tool to help communities set rooftop solar goals based on available resources.

Implementing Solar PV Projects on Historic Buildings and in Historic Districts – This report from NREL provides guidance on implementing PV on historic properties, including how to engage stakeholders, follow review procedures, implement projects, and evaluate impacts.

IREC Community Solar Basics – This reference guide from IREC gives a brief overview of seven critical program design elements along with accompanying checklists and additional resources to help guide decision makers and stakeholders as they develop community solar programs.

IREC Guiding Principles for Shared Solar Energy Programs – These guiding principles from IREC reflect the benefits of shared renewable energy programs to participants, the renewable energy industry, utilities, and all energy consumers.

IREC Model Inspection Checklist for Residential Rooftop PV – This model checklist incorporates the best components of checklists from various leading U.S. jurisdictions.

Just Energy Policies: Model Energy Policies Guide – This guide from the NAACP Environmental and Climate Justice Program identifies five policies that can advance the transition to a more inclusive, clean, and equitable energy economy. These policies include renewable portfolio standards (RPS), energy efficiency resource standards, net metering standards, distributed generation, and community renewable energy.

Just Energy: Reducing Pollution, Creating Jobs Toolkit – This toolkit from the NAACP provides guidance for energy justice organizing.

K-12 Solutions for Building Energy Excellence – This document shares practices, programs, and policies that help advance clean energy goals and build energy literacy in STEM curricula.

Lessons Learned: Community Solar for Municipal Utilities – This summary from NREL discusses specific case studies of municipalities implementing community solar projects, the range of approaches they are taking, and challenges other municipal utilities face in deciding to pursue community solar.

Local Government Project Portal: Goal-Setting Guidance – This guide from the EPA provides information on why and how to set a renewable electricity goal and the considerations that should be taken into account. There is also a worksheet for users with actionable steps.

Local Government Strategies for 100% Clean Energy – This webinar from SolSmart provides an overview for setting clean energy goals, including considerations related to COVID-19.

Low- and Moderate-Income Solar Policy Basics – This web page from NREL gives an overview of LMI solar, including barriers to LMI solar uptake, financing mechanisms, and information on community solar, as well as providing additional resources.

Low-Income Energy Affordability: Conclusions from a Literature Review – This report from Oak Ridge National Lab studied more than 180 publications pointing to promising ways of addressing energy affordability through inclusive solar programs, leveraged health care benefits, grid resiliency, and use of behavioral economics and data analytics.

Low-Income Energy Affordability Data (LEAD) Tool – This DOE tool provides estimated low-income household energy data at state and local levels. Data include energy burdens, housing units, and income levels.

Low-Income Energy Library: Federal Resources and Tools – DOE created this tool to provide a one-stop location for low-income energy resources across the federal government, including financing.

Low-Income Solar Policy Guide – This guide—developed by GRID Alternatives, Vote Solar, and the Center for Social Inclusion—summarizes barriers to low-income solar and provides information on successful programs, policy tools, and models.

Low-Income Solar Policy Guide: Financing – This web page from the Low-Income Solar Policy Guide, developed by GRID Alternatives and Vote Solar, lists policy tools that provide options to expand access to financial solutions for low-income families to access solar.

Low-Income Solar Policy Guide: Green Banks – This web page provides an overview of Green Banks and how they support low-income solar.

Map and Timelines of 100% Clean Energy States – This map from CESA tracks states' 100% clean energy commitments and timelines.

Microgrids for Resiliency – This report from DOE and NREL discusses the value that microgrids can provide to utilities and customers.

Model Zoning for the Regulation of Solar Energy Systems – This document from the Massachusetts Department of Energy Resources provides model zoning language and guidance to local governments to establish standards that facilitate solar energy development.

Multifamily Green Retrofit Toolkit – This toolkit from the U.S. Department of Housing and Urban Development provides guidance for the various stages of upgrading multifamily properties.

National Community Solar Partnership – NCSP is a coalition of community solar stakeholders working to expand access to affordable community solar to every American household by 2025. Technical assistance is available to members. NCSP also includes focused collaboratives and educational materials.

National Community Solar Partnership: Multifamily Affordable Housing Collaborative – This NCSP collaborative is made up of stakeholders who are working together to expand access to community-based solar to MFAH buildings.

National Solar Jobs Census 2020 – The National Job Census is a collaborative effort of SEIA, the Solar Foundation, and IREC. It tracks domestic solar employment across all solar industry market sectors.

Navigating Options for Transportation Electrification and Solar Charging – This report from the Montana Solar Energy Innovation Network Team assists communities that are considering investing in electric transportation. It includes background information, costs and benefits, and information on EVs plus renewable energy.

Non-Power Purchase Agreement Options for Financing Solar Deployment at Universities – This fact sheet from NREL discusses financing models and funding mechanisms for solar procurement, with a focus on non-PPA financing models. The fact sheet focuses on universities, but the lessons can be applied more broadly.

NREL's Community Solar web page – This web page from NREL provides information and resources on community solar, including its current market status, common barriers, overall benefits, design best practices, and pertinent publications.

NREL's Green Banks web page – This NREL web page gives an overview of Green Banks and the products they provide, as well as information on their formation.

NYSERDA P-12 Schools Initiative – P–12 is defined as pre-kindergarten through grade 12 education. The P–12 Schools Initiative encourages schools to lower energy use and utility bills while reducing greenhouse gas emissions.

NYSERDA: 2018 Resource Guide to Solarize Campaign Success – This is a roadmap from NYSERDA for local leaders who want to make solar more accessible and affordable through a Solarize campaign.

NYSERDA Solar Guidebook – This guidebook includes the "Model Solar Energy Local Law" which local officials may use when adopting their own rules for solar development. This guidebook additionally includes a section on "Solar Permitting and Inspecting," which reviews the solar permitting and inspection process for local government officials and authorities having jurisdiction (AHJs), as well as the New York State Unified Solar Permit Application and Field Inspection Checklist.

Owning the Benefits of Solar + Storage – This report from the Clean Energy Group describes ownership and financing models for solar plus storage in affordable housing and community facilities.

PACENation – This web page provides information about adopting a local PACE program.

Permitting Best Practices Make Installing Solar Easier – This fact sheet from NREL outlines seven best practices to improve permitting for PV; many include ensuring transparent processes.

Planning and Implementing a Solarize Initiative: A Guide for State Program Managers – This guide by CESA features detailed cases studies of two successful Solarize programs—Solarize Connecticut and Solarize Mass.

Planning, Zoning & Development – This section from the SolSmart Toolkit for Local Governments discusses how communities can integrate solar into local zoning codes and planning documents.

Power Purchase Agreement Checklist for State and Local Governments – This fact sheet from NREL provides guidance on PPAs for local and state government entities.

Power Sector Resilience Planning Guidebook: A Self-Guided Reference for Practitioners – This guidebook from USAID and NREL introduces decision makers to the concepts and steps involved in power sector resilience planning.

Procurement Guidance – This guide for cities is from the Cities Renewables Accelerator and was developed by RMI and World Resources Institute to support the Bloomberg Philanthropies American Cities Climate Challenge and the Urban Sustainability Directors Network cities. It helps city governments understand all parts of municipal renewable energy projects.

Property Assessed Clean Energy Programs – This DOE resource provides information about commercial and residential PACE financing programs.

Ready for 100% Interactive Map – This map, provided by the Sierra Club, details which states and communities have set 100% renewable energy or 100% carbon-free goals.

Renewable Energy Toolkit for Affordable Housing – This toolkit, from the Department of Housing and Urban Development's Office of Community Planning and Development, provides a step-by-step guide to integrating renewable energy into affordable housing projects in a way that is efficient, cost-effective, and impactful.

RE-Powering America's Land Initiative: Community Solar – This EPA report discusses siting community solar on superfund sites, brownfields, landfills, and mine sites, as well as other formerly contaminated sites, under various federal and state cleanup programs.

Residential Property Assessed Clean Energy (R-PACE): Key Considerations for State Energy Officials – This issue brief from NASEO details the basic mechanism of an R-PACE program and the considerations that state energy officials should account for when enabling PACE programs at the state level.

Resilience Roadmap: A Collaborative Approach to Multi-Jurisdictional Planning – This step-by-step process from NREL offers guidance for a multi-jurisdictional approach to resilience planning.

Resilient Power Project Map – This map from the Clean Energy Group tracks resilient energy projects in the United States.

Resilient Power Project Toolkit – This toolkit from the Clean Energy Group provides information and resources to help gain a better understanding of resilient power systems and how to approach the planning and development of a resilient power installation.

Resources To Support Initiatives for Low-to-Moderate Income Communities (Part 1) – This webinar from SolSmart is a resource for local governments to understand how to expand solar and energy efficiency deployment in LMI communities. The second webinar in this series provides examples of projects.

School and Municipal Solar – This page from the Vermont Energy and Climate Action Network provides guides, templates, and case studies for schools and municipalities pursuing solar.

Shared Accountability Framework: For Community Implementation of 100% Clean Energy Goals – This tool for evaluation from the Sierra Club helps leaders prioritize equity and justice while evaluating a community's process toward the transition to 100% clean energy. The Companion to the Shared Accountability Framework can help jurisdictions use the framework effectively.

Shared Renewable Energy for Low- to Moderate-Income Consumers: Policy Guidelines and Model Provisions – This document from IREC provides information and tools for policymakers, regulators, utilities, shared renewable energy developers, program administrators, and others to support the adoption and implementation of shared renewables programs designed to provide tangible benefits to LMI individuals and households.

Smart Grids in Emerging Markets—Private Sector Perspectives – This fact sheet from USAID and NREL provides an introduction to smart grids, the benefits that smart grids can provide to the grid and to consumers, and policy and technical support considerations that could improve private sector investment in smart grids.

Solar Access Guide – This guide from the city of Boulder, Colorado, provides information about the solar access regulations that apply to construction.

Solar Access: Issues and Policy Options – This blog post from NREL discusses solar energy access and the policy landscape around solar energy access.

Solar Career Map – This map from IREC describes 40 jobs across four solar industry sectors (manufacturing, system design, project development, and installation and operations) and outlines over 60 potential routes to advance between these jobs.

Solar Career Map: About the Industry – IREC provides information about different parts of the solar industry (manufacturing, system design, project development, and installation and operations), as well as jobs, career pathways, and solar training.

Solar Decathlon Career Resources – The U.S. Department of Energy Solar Decathlon® fosters collaboration that mimics the real-life workplace environment among students from different academic disciplines, including engineering, architecture, building science, interior design, business, marketing, and communications. These career resources offer information about job opportunities related to competing in the Solar Decathlon, as well as building careers in solar energy, bioenergy, and wind energy.

Solar Decision Support and Resources for Local Governments – NREL offers decision support and resources for local governments that want to go solar. Training webinars cover topics ranging from site evaluation to project financing, as well as case studies.

Solar Energy International – SEI is a nonprofit educational organization dedicated to equitable solar workforce development. This website has training resources, job boards, and other resources.

Solar Energy International Solar in the Schools Program – This program focuses on training a young workforce for jobs after high school.

Solar For Schools: A Case Study in Identifying and Implementing Solar Photovoltaic (PV) Projects in Three California School Districts – This NREL case study and reference document details the steps and processes that could be used to successfully identify, fund, and implement PV projects in school districts across the country.

Solar Guidance and Model Ordinance Development – This resource, developed by the state of Rhode Island Office of Energy Resources, includes two solar siting guidance reports and an informational PowerPoint for municipalities to help explain the state's regulations.

Solar Panels on Historic Properties – This guide from the National Park Service discusses how solar panels can be installed on historic properties.

Solar-Plus-Storage 101 – This DOE guide provides a basic overview of solar-plus-storage projects, including information on the technology and associated costs.

Solar Power + Electric Vehicle Charging: Capturing Synergies in Minnesota – This report from the Great Plains Institute discusses market transformation opportunities and barriers for solar plus EVs in Minnesota. Lessons learned can be applied in other jurisdictions.

Solar Project Development Pathway & Resources – This web page by the U.S. Environmental Protection Agency describes seven steps for solar project development by local governments. It provides links to videos, guides, templates, reports and case studies to assist in the process at each step.

Solar PV Emergency and Resilience Planning – This fact sheet from SolSmart discusses the role that solar can play in risk management, response, and recovery from natural disasters.

Solar PV on Municipal Buildings: A Guide to Feasibility and Financial Analysis – This resource from C40 provides step-by-step guidance for local government staff to carry out high-level feasibility and financial analysis of PV deployment.

Solar Ready KC – This white paper from the Mid-America Regional Council discusses best management practices for solar installation policy in Kansas City, Missouri, and includes a section on the benefits of and necessary steps for adopting ordinances that promote solar-ready construction.

Solar Ready Vets – IREC leads the Solar Ready Vets Network, a program that connects transitioning military service members and veterans with career opportunities in the solar industry.

Solar Ready Vets Network – This group of solar workforce development programs funded by DOE connects veterans with career training, professional development, and employment opportunities in the solar industry.

Solar Ready: An Overview of Implementation Practices – This NREL resource summarizes technical considerations for solar-ready building designs.

Solar TRACE – The Solar Time-Based Residential Analytics and Cycle Time Estimator (Solar TRACE) tool from NREL can help increase the transparency of soft costs like permitting, inspection, and interconnection.

Solar With Justice: Connecting States and Communities – This CESA project works with state energy agencies and CBOs in under-resourced communities so that they are better able to share the knowledge and information needed for solar to be developed efficiently, equitably, and cost-effectively in LMI communities.

Solar With Justice: Strategies for Powering Up Under-Resourced Communities and Growing an Inclusive Solar Market – This guide from CESA provides recommendations for how to accelerate solar implementation in under-resourced communities.

Solar@Scale Guidebook – This local government guidebook developed by ICMA provides guidance for improving large-scale solar development outcomes.

SolarAPP+ – SolarAPP+ is a free online web portal developed by NREL that automates the plan review and process for issuing permits to install code-compliant residential PV systems.

SolarCorps Fellowship Program – GRID Alternatives runs an 11-month paid fellowship program for people starting or furthering a career in clean energy.

Solarize Campaigns: Helping Communities of Color Access Rooftop Solar – This article from RMI discusses how solarize campaigns can reduce energy burdens for communities of color by increasing access to rooftop PV.

Solarize Your Community – This guide from Yale is based on a research project on Solarize Connecticut, a set of campaigns that were launched across Connecticut from 2013 to 2016.

Solar-Ready Building Design: A Summary of Technical Considerations – This NREL report, intended for local, state, and federal decision makers, discusses tools and methods for promoting widespread solar-ready building practices. It also includes sample legislation drafted to require that new residential and commercial construction be solar ready.

SolSmart Issue Brief: Expanding Solar Participation Through Community Solar – This SolSmart Issue Brief describes the community solar model and highlights approaches for developing new projects. It discusses why community solar can be beneficial, the ingredients of successful programs, and case studies of successful community solar programs across the country.

SolSmart Program Guide – This guide outlines the criteria for being designated a SolSmart community, many of which involve process transparency. The guide also includes specific examples and templates.

SolSmart Webinar: How To Develop a Solarize Campaign – In this webinar, SolSmart covers the basics of a successful Solarize campaign. Experts from Solar United Neighbors and the Philadelphia Energy Authority share how a Solarize campaign can keep more economic value in the community and how a campaign can be modified to enable participation by LMI customers.

SolSmart Workshop: Best Practices for Solar PV Permitting Session 1 and Session 2 – These recorded workshops discuss how to improve PV permit review and train inspection staff on best practices for inspecting PV systems.

SolSmart's Community Solar Toolkit for Local Governments – SolSmart's Community Solar web page provides an overview of community solar, virtual net metering, community solar ownership models, and implementation tips for local governments.

SolSmart's Solar Permitting Page – This page provides the steps necessary for a local government to implement a simplified permitting process.

SolSmart's Toolkit for Local Governments: Solar PV Construction – This guidebook presents information on codes, permitting, and inspection, including the benefits of simplified processes and best practices.

SolSmart's Toolkit for Local Governments: Market Development and Finance – This document covers mechanisms available for local governments to increase solar financing opportunities, including loan options, PACE financing, Solarize campaigns, and specific financing tools local governments can utilize to increase solar adoption in LMI households.

SolSmart's Toolkit for Local Governments: Resiliency – This section of SolSmart's Toolkit for Local Governments explains how solar-plus-storage systems work and provides guidelines for communities on how to foster the development of this technology as well as successful examples at the local level.

SolSmart's Toolkit for Local Governments: Stakeholder Engagement – This chapter from the SolSmart Toolkit for Local Governments provides guidance to local government staff on stakeholder engagement.

State of Green Banks 2020 – This report from RMI provides information about Green Banks around the world and the progress of new institutions.

State Pollinator-Friendly Solar Initiatives – This report from CESA provides an overview of state efforts to encourage solar PV development in a manner that is beneficial to pollinators.

Strategies for Workforce Development: A Toolkit for the Solar Industry – This toolkit from the Solar Foundation and the Solar Training Network describes scalable and industry-driven solutions to align training efforts with the needs of the workforce.

The National Community Solar Partnership – NCSP is a coalition of community solar stakeholders working to have community solar projects provide 26 GW of power and create US$1 billion in bill savings by 2025. Technical assistance is available to members. NCSP also includes partner collaboratives that work together to identify and address common barriers, as well as educational materials. See also the Municipal Utility Collaborative offered through NCSP.

The Road Ahead: Planning for Electric Vehicles by Managing Grid Interactions – This report from the National Governors Association discusses transportation electrification and the steps needed to make this transition.

The Role of Smart Grids in Integrating Renewable Energy – This report from NREL discusses the role that smart grids can play in integrating renewable energy into a system, and discusses smart grid technology, policy, and regulation from the perspective of a decision maker.

Tracking the Sun – This report and interactive data visualizations from LBNL summarizes installed prices and other trends among grid-connected distributed PV systems in the United States.

U.S. Climate Alliance: Solar Deployment Guidebook – This guidebook from NASEO was designed to equip state and local agencies with tools, strategies, and models on proven soft cost reduction methods in the following areas: permitting and inspection; zoning and siting; municipal procurement; and property taxes.

U.S. Solar Industry Diversity Study 2019 – This report from SEIA and the Solar Foundation is a study on diversity and inclusion in the solar workforce. It includes information on career pathways, wages, satisfaction, and career development. It also provides strategies that companies can use to increase diversity and inclusion.

U.S. Solar Photovoltaic System and Energy Storage Cost Benchmark: Q1 2020 – This NREL report provides information on PV system costs, including information on residential and commercial soft costs.

Understanding Solar + Storage – This report from the Clean Energy Group answers frequently asked questions about solar PV and battery storage.

Unlocking Solar for Low- and Moderate-Income Residents: A Matrix of Financing Options by Resident, Provider, and Housing Type – This NREL report identifies the most promising strategies policymakers might consider using to finance PV for LMI customers across three housing types: single-family, multifamily, and manufactured housing.

Utility Community Solar Handbook – This handbook from the Solar Electric Power Association provides the utility's perspective on utility-managed community solar program development. The handbook serves as a resource for government officials, regulators, community organizers, solar energy advocates, nonprofits, and interested citizens who want to support or educate their local utility in implementing a new community solar project or improving an existing one.

Vermont Energy and Climate Action Network: Getting Started – This resource covers the creation and operation of committees focused on renewable energy and climate change solutions.

What Can Green Banks Do for Rural Areas? – This article from the Environmental and Energy Study Institute provides information on how Green Banks can benefit rural communities.

What Is a Solar Easement? – This article from EnergySage discusses solar easements and lists states that allow solar easements. It also briefly discusses solar access laws.

Wherever the Sun Shines: Bringing Solar Power to All Households – This guidebook from Yale includes insights from field studies that were conducted during a series of Yale-led Solarize campaigns run by the nonprofit SmartPower.

Will Solar Panels Help When the Power Goes Out?: Planning for PV Resilience – This report from NREL discusses how solar can contribute to resilience with careful design and planning.

Working Effectively With Tribal Governments – This guide from the state of Michigan provides information about tribal communities, including an introduction to concepts, federal law, and tips for working more effectively with tribal governments.

Appendix C: Tools for Implementing Solar Locally

Many tools have been developed to help local governments and other stakeholders implement solar in the most effective, efficient, and equitable ways possible. The tools listed in Table 1Table 4 aid in understanding the different aspects of solar adoption, including solar savings, production potential, costs associated with adopting solar, and dimensions of LMI energy usage at the local level.

Table 4. Tools for Community-Level Solar Development

Tool	Tool Host	Tool Description	Benefits to Local Governments
DeepSolar	Stanford	DeepSolar analyzes satellite imagery to identify locations and sizes of U.S. PV panels.	This tool helps determine the number of local solar installations.
LEAD	DOE	The Low-Income Energy Affordability Data (LEAD) tool is designed to help states, communities, and other stakeholders create better energy strategies and programs by improving their understanding of low-income housing and energy characteristics.	This tool can be used to reduce energy costs and target energy affordability services and energy savings services to eligible LMI customers in specific areas.
NSRDB	NREL	The National Solar Radiation Database (NSRDB) provides hourly and half-hourly values of meteorological data and the three most common measurements of solar radiation: global horizontal, direct normal, and diffuse horizontal irradiance. This data is used to power several of the models listed here.	The NSRDB provides the data behind many of the powerful models listed here. Local government officials or stakeholders may choose to access this data to reinforce solar planning decisions.
Project Sunroof	Google	Project Sunroof is a solar calculator from Google that displays solar potential and impact across entire geographic areas and can provide solar savings potential for specific locations.	This tool can be used to estimate the solar potential for a local jurisdiction.
PVWatts Calculator	NREL	The PVWatts tool estimates the energy production and cost of energy of grid-connected PV energy systems at any location throughout the world. It allows homeowners, small building owners, installers, and manufacturers to easily develop estimates of the performance of potential PV installations.	This tool can provide estimates of a system's annual and monthly electricity production and an estimate of the value of that electricity for a system on a government building (or at any specific location).

Tool	Tool Host	Tool Description	Benefits to Local Governments
REopt and REopt Lite	NREL	The REopt® techno-economic decision support platform is used by NREL researchers to optimize energy systems for buildings, campuses, communities, microgrids, and more. REopt recommends the optimal mix of renewable energy, conventional generation, and energy storage technologies to meet cost savings, resilience, and energy performance goals. REopt Lite® is the publicly available online version of the tool.	This tool can be utilized by local governments to create optimized systems for local government buildings, ensuring they are meeting energy performance and/or resilience goals.
SAM Tool	NREL	The System Advisor Model (SAM) is a performance and financial model designed to estimate the cost of energy for grid-connected power projects based on installation and operating costs and system design parameters.	This model can calculate a project's levelized cost of energy, which represents the cost of installing and operating the system, including debt and tax costs, and accounts for incentives.
SLOPE	NREL	The State and Local Planning for Energy (SLOPE) platform delivers jurisdictionally resolved potential and projection data on energy efficiency, renewable energy, and (coming soon) sustainable transportation to enable data-driven state and local energy planning.	This platform makes it easier for state and local governments to consider, compare, or fully capture the value of energy efficiency, renewable energy, and sustainable transportation-related resources.
Solar Demographics Tool	LBNL	The Solar Demographics tool allows users to visualize and download data from the Lawrence Berkeley National Laboratory (LBNL) report, *Income Trends Among U.S. Residential Rooftop Solar Adopters*.	This tool provides information on solar adoption based on income level.
SolarAPP+	NREL	SolarAPP+ is an online web platform that automates the solar plan review process for residential PV permits to install code-compliant residential PV systems.	This tool can be used by local governments to automate and streamline residential rooftop solar permitting.
Tracking the Sun Visualization	LBNL	Tracking the Sun allows users to access data about distributed solar, including installed system prices, customer segmentation, mounting configuration, and more.	This visualization tool helps to establish a local baseline and clarify the status of solar in an area.
Tribal Energy Atlas	NREL	The Tribal Energy Atlas was developed by NREL and DOE's OIE, and shows the data generated and collected as part of the NREL study *Techno-Economic Renewable Energy Potential on Tribal Lands*.	This tool can help a local community see if there are federally recognized tribal communities or lands nearby.

Appendix D: List of All Case Studies

- Austin, Texas
  - Solar-Ready in Austin, Texas
  - Included in Section 3.2
  - More information: Austin's Solar Ready Guidelines, Austin's Solar-Ready Ordinance, Austin's SolSmart designation page, and Ready for Solar? Austin Becomes Third City in Texas To Make New Buildings "Solar-Ready".
- Bad River Band, Wisconsin
  - Bad River Band of Lake Superior Tribe of Chippewa Indians Microgrid Project
  - Included in Section 1.6
  - More information: Common Ground, New Microgrid Is a Symbol of Resilience for Bad River Band, and Long Range Energy Planning Report.
- Batesville, Arkansas
  - Energy Savings Allow for Investments in Teachers in Batesville, Arkansas
  - Included in Section 4.1
  - More information: Generation180's Batesville case study.
- Blue Lake Rancheria, California
  - EV Charging, Microgrid, and Resilience in Blue Lake Rancheria
  - Included in Section 1.6
  - More information: Blue Lake Rancheria Microgrid, Blue Lake Rancheria Receives FEMA's 2017 Whole Community Preparedness Award, and Blue Lake Rancheria Transportation.
- Boulder, Colorado
  - Solar Lease Agreements for City of Boulder Facilities
  - Included in Section 2.2
  - More information: Boulder's Generation Solar website.
- Bronzeville, Illinois
  - Bronzeville Microgrid Project
  - Included in Section 1.6
  - More information: ComEd Gets $4 Million To Build Microgrid in Bronzeville, Solar Housing Linked to Bronzeville Microgrid Provides Social Justice, Technology Research.
- California
  - California Shade Control Act
  - Included in Section 3.1
  - More information: California's Solar Shade Control Act: A Review of Statutes and Relevant Cases, Solar Easement and the Solar Shade Control Act: Program Overview, and Solar Shade Control Code.
- Chattanooga, Tennessee
  - Chattanooga Turnaround Time

  - Included in Section 3.3
  - More information: Chattanooga Solar Panels and SolSmart's Case Study on Chattanooga.
- Delta County, Colorado
  - Training High School Students for Solar Careers in Delta County, Colorado
  - Included in Section 4.1
  - More information: SEI's case study or Innovative Solar System's web page.
- Denver, Colorado
  - Denver Housing Authority Lighting the Way for Solar on MFAH
  - Included in Section 6.3
  - More information: DHA's Community Solar Project Keeps Housing Affordable, Expanding Solar Availability to the Low-Income Community: Learnings From the Denver Housing Authority, the Solar in Your Community Challenge home page, and Denver's SolSmart designation page.
- Douglas County and Hood River County, Oregon
  - Making Energy Work for Rural Oregon
  - Included in Section 1.2
  - More information: Solar in Your Community Challenge and Sustainable Northwest.
- East Salinas, California
  - Santa Rita Union School District Solar Plus Storage
  - Included in Section 6.1
  - More information: Solar-Plus-Storage Microgrids Installed in Santa Rita Schools.
- Easthampton, Massachusetts
  - Solar Array on a Landfill in Easthampton, Massachusetts
  - Included in Section 6.4
  - More information: Letting the Sunshine In and Powering Up Landfill.
- Edina, Minnesota
  - Edina, Minnesota, Hosts Local Community Solar Garden
  - Included in Section 6.1
  - More information: Edina's Electricity Action Plan, SolSmart's Edina case study, and Edina's SolSmart designation page.
- Fairfax County, Virginia
  - Fairfax County Community-Wide Energy and Climate Action Plan
  - Included in Section 1.3
  - Climate Change Planning and Action, Solarize Fairfax County, and Fairfax County's SolSmart designation page.
- Fort Collins, Colorado
  - Riverside Community Solar in Fort Collins, Colorado
  - Included in Section 6.2

    - More information: SolSmart's Community Solar Toolkit for Local Governments, Fort Collins Community Solar web page, and Fort Collins' SolSmart designation page.
- Golden, Colorado
    - Golden Opportunities for Solar and Sustainability
    - Included in Section 1.1
    - More information: City of Golden's Community Sustainability Advisory Board, Golden's SolSmart designation page, and the 2020 City of Golden Sustainability Strategic Plan.
- Grand Junction, CO
    - On-bill Financing in Grand Junction, Colorado
    - Included in Section 2.4
    - More information: Low-Income Solar Policy Guide's On-Bill Financing page and Insights from the Colorado Energy Office: Low-Income Community Solar Demonstration Project.
- Houston, Texas
    - Houston Brownfield Solar Project
    - Included in Section 6.4
    - More information: City Selects Firm Proposing Solar Energy Farm at Former Sunnyside Landfill, and Sunnyside Landfill.
- Los Angeles, California
    - Los Angeles 100% Renewable Energy Study (LA100)
    - Included in Section 1.5
    - More information: LA100: The Los Angeles 100% Renewable Energy Study Executive Summary, LA100: Chapter 4, Customer-Adopted Rooftop Solar and Storage, and the LA100 Website, "Pioneering NREL Analysis Empowers Los Angeles in Its Pursuit of 100% Renewables."
- Madison, Wisconsin
    - GreenPower Program in Madison, Wisconsin
    - Included in Section 4.3
    - More information: Madison's GreenPower web page.
- Michigan
    - Michigan Solar Zoning Database
    - Included in Section 3.1
    - More information: Michigan Zoning Database and EGLE Launches Unique Renewable Energy Ordinance Database of Michigan Communities.
- Milwaukee, Wisconsin
    - Milwaukee Shines Program Grows Solar Locally
    - Included in Section 2.3

    - More information: Grow Solar home page, Milwaukee Shines home page, and Milwaukee's SolSmart designation page.
- Montgomery County, Maryland
    - Montgomery County Green Bank
    - Included in Section 2.3
    - More information: Montgomery County Green Bank's home page, the 2020 Annual Report, and Montgomery County's SolSmart designation page.
- New York
    - New York Prohibits Unreasonable Restrictions From Homeowner Associations
    - Included in Section 3.1
    - More information: NY State Senate Bill S2997.
- Philadelphia, Pennsylvania
    - Solarize Philly Brings Solar to LMI Residents
    - Included in Section 2.3
    - More information: Solarize Philly's home page, Philadelphia's SolSmart designation page, and Up to the Challenge: Communities Deploy Solar in Underserved Markets.
- Picuris Pueblo Tribe, New Mexico
    - Picuris Pueblo of New Mexico 100% Renewable Goal
    - Included in Section 1.5
    - More information: Final Report Pueblo of Picuris.
- Plano, Texas
    - Solar in a Historic District in Plano, Texas
    - Included in Section 3.1
    - More information: Design Standards and Downtown Heritage Resource District Story Map.
- Rhode Island
    - Rhode Island LMI Solar Strategy and Survey
    - Included in Section 5
    - More information: Expanding Access to Solar for Low-to-Moderate Income Households and Communities: Lessons Learned for State Agencies and Rhode Island Low-Moderate Income Solar Strategy.
- Salt Lake City, Utah
    - Solar Salt Lake Partnership
    - Included in Section 1.3
    - Solar in Action: Salt Lake City, Solar Briefing - Solar Community Engagement Strategies for Planners, and Salt Lake City's SolSmart designation page.
- San Francisco, California
    - San Francisco's First Source Hiring and GoSolarSF
    - Included in Section 4.3

    - More information: First Source Hiring Program.
- San Juaquin, California
    - Inspection Transparency in San Joaquin County, California
    - Included in Section 3.3
    - More information: San Joaquin County's building permit page and Solar PV System Permit Checklist.
- Sarasota County, Florida
    - PACE in Sarasota County, Florida
    - Included in Section 2.3
    - More information: PACE home page, PACE FAQ, Sarasota County's SolSmart case study, and the county's SolSmart designation page.
- Sayreville, New Jersey
    - Floating Solar in Sayreville, New Jersey
    - Included in Section 6.4
    - More information: New Jersey Town Keeps Its Water Clean With the Country's Largest Floating Solar System and New Jersey Installs Largest Floating Solar System In North America.
- Swampscott, Massachusetts
    - Swampscott Community Power
    - Included in Section 2.2
    - More information: Swampscott Community Power.
- Tippecanoe County, Indiana
    - Solar Powering Sunnyside
    - Included in Section 1.3
    - More information: Solar Powering Sunnyside.
- Tucson and Pima County, Arizona
    - Instant Solar Permitting in Tucson and Pima County, Arizona
    - Included in Section 3.3
    - More information: this article from Tucson and Pima County, SolarAPP+, and Pima County's SolSmart designation page.
- Villages of Brockport and Lima, New York
    - Opt-Out Community Solar via CCA in New York
    - Included in Section 2.2
    - More information: Groundbreaking Opt-Out Community Solar Program in Brockport and Lima, NY Moves Toward Launch as the Villages Select Solar Provider.
- Washington, D.C.
    - Solar Works DC, and Community Solar in Washington, D.C.
    - Included in Section 4.3 and Section 6.2
    - More information: Madison's GreenPower web page.

- Watertown, Massachusetts
  - Commercial Solar Mandate in Watertown, Massachusetts
  - Included in Section 3.2
  - More information: Planning Board Zoning Amendments, this press release from the Massachusetts Municipal Association, and this PV Magazine article: Solar Required on New Commercial Buildings in Massachusetts Town.

Glossary

Agrivoltaics: The co-location of agriculture and solar photovoltaic (PV) infrastructure.

Black Start Capabilities: The ability of generation to restart parts of the power system to recover from a blackout. This entails isolated power stations being started individually and gradually reconnected to one another to form an interconnected system again.

Brownfields: Unproductive, abandoned, or contaminated sites with polluted soils.

Community Solar: A distributed solar energy deployment model that allows customers to buy or lease part of a larger, off-site shared solar photovoltaic (PV) system. A community solar project is one that has multiple subscribers who receive benefits on utility bills that are directly attributable to the project. Also known as shared solar or solar gardens.

Consolidated Billing: A billing structure under which one party, often the utility, acts as the billing and collection agent. This party collects payment for both the utility and the community solar developer by collecting the consolidated billing subscription fee and the utility billed amount and providing the community solar credit, all in one consolidated bill.

Curtailment: A reduction in the output of a generator from what it could otherwise produce given available resources, typically on an involuntary basis.

Distributed Energy: Electrical generation and storage performed by a variety of small, grid-connected or distribution system-connected devices.

Distributed Energy Resources: Small, modular, energy generation and storage technologies that provide electric capacity or energy where you need it.

Distributed Solar PV: A variety of solar photovoltaic technologies, that generate electricity at or near where it will be used. For the purpose of this document, we include residential solar, community solar, and small commercial solar installations connected to the distributed grid.

Energy Burden: The percentage of gross household income spent on energy costs.

Installed Solar Capacity: The amount of solar PV installed in a specified area, typically measured in watts, kilowatts, megawatts, or gigawatts.

Investment Tax Credit (ITC): The ITC is a percent federal tax credit claimed against the tax liability of residential (under Section 25D) and commercial and utility (under Section 48) investors in solar energy property. The Section 25D residential ITC allows the homeowner to apply the credit to his/her personal income taxes. The Section 48 credit allow businesses that install, develop and/or finance the project to claim the credit (SEIA n.d.).

Microgrid: An interconnected group of loads and distributed energy resources acting as a single controllable grid entity, with the ability to connect and disconnect from the grid to operate in grid-connected or island mode.

Net Energy Metering (NEM): A metering and billing arrangement designed to compensate distributed energy generation system owners for any generation that is exported to the utility grid. Commonly referred to as net metering.

Nonresidential Solar: Commercial, government, nonprofit, or community solar.

On-Bill Crediting: A crediting system that enables standalone generators (i.e., community solar) to allocate credits generated through a subscription directly to an off-site customer's electric bill, with the credit valued at the customer's basic service rate.

Property Assessed Clean Energy (PACE): A financing program that allows residential and commercial property owners to finance the upfront cost of renewable energy on a property, then pay the costs back over time through an assessment directly attached to the property through a locally filed lien.

Resilience: The ability to anticipate, prepare for, and adapt to changing conditions and withstand, respond to, and recover rapidly from disruptions through adaptable and holistic planning and technical solutions.

Smart Grid: The combination of information, sensing, control, and energy technologies to produce an integrated electric power system. Smart grid technologies include smart meters and sensors, integrated storage, EV charging stations, smart appliances, advanced building automation and control systems, and two-way communications integrated into technologies and appliances.

Soft Costs: Non-hardware costs that include design, siting, permitting, installation, interconnection, and financing. They also include the sales, general, and administrative expenses solar companies incur for customer acquisition, workforce training and certification, supply chain and inventory control, and operating overhead.

Solar Plus Storage: A solar PV installation paired with an energy storage system such as a battery.

Solar Rights: A property owner's right to install a solar energy system.

Solar Access: The ability to get sunlight for an array.

Solarize Campaign: A local campaign to reduce the upfront cost of solar by giving groups of individuals or businesses a discounted rate for bulk purchases—via savings from reduced marketing costs and economies of scale. Also known as solar group purchases or group buy campaigns.

Split Incentives: A circumstance in which the investment required to install solar, and the resulting benefits are not properly rationed between landlords or building owners and tenants.

Underserved Communities: Populations and geographic communities that have been systematically denied a full opportunity to participate in aspects of economic, social, and civic life.

Virtual Net Energy Metering (VNEM): A metering system that utilizes the same compensation mechanism and billing schemes as net metering, without requiring that a customer's distributed generation system (or share of a distributed generation system) be located directly on-site.

Zoning: A method of urban planning in which a municipality or other tier of government divides land into areas called zones each of which has a set of regulations for new development.

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