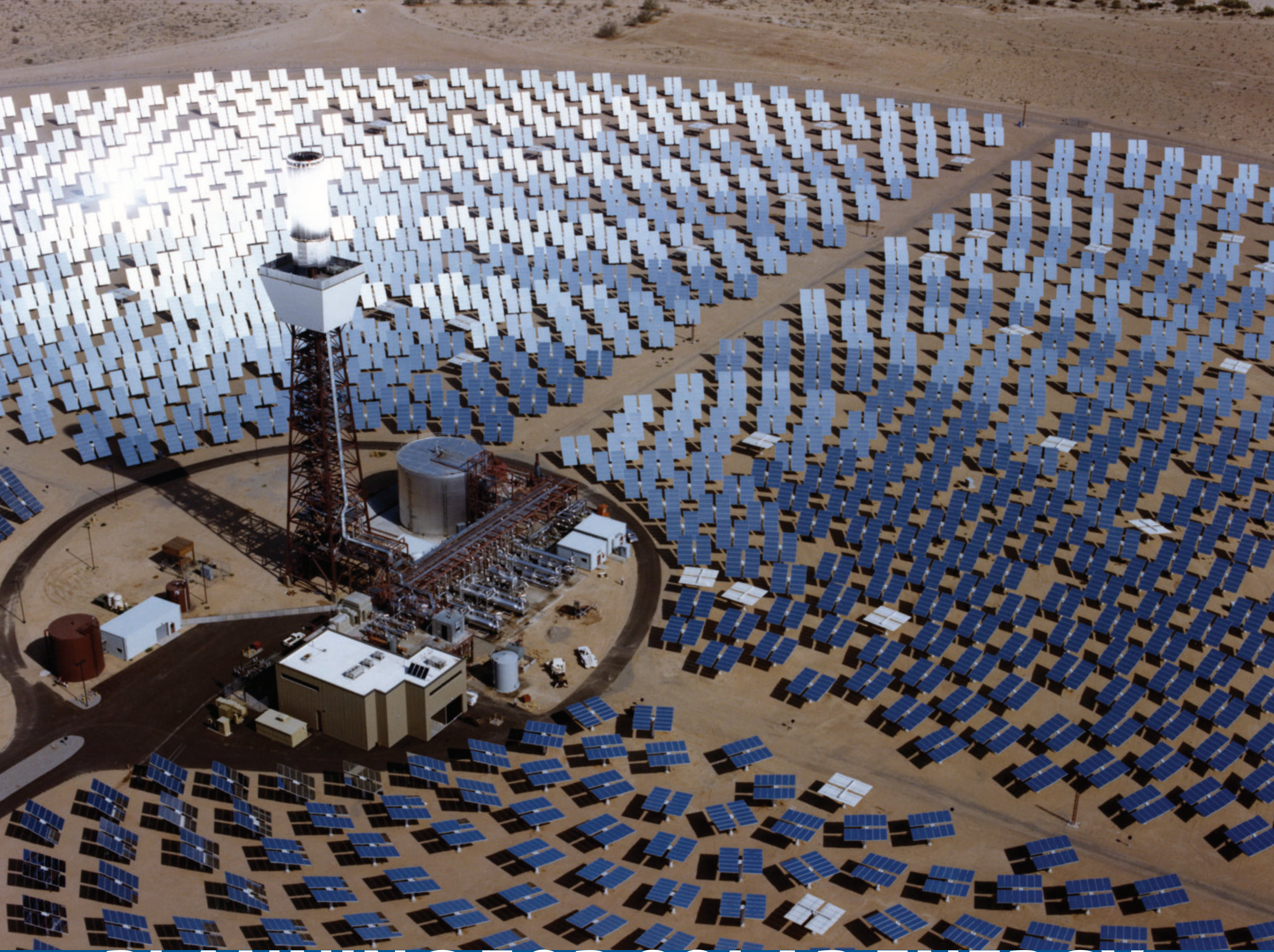

PLANNING FOR SOLAR ENERGY BRIEFING PAPERS

American Planning Association
Making Great Communities Happen

Powered by SunShot
U.S. Department of Energy

About This Compendium

Planners are uniquely positioned and qualified to help their communities engage in conversations about the potential benefits of solar energy use and create a local policy framework that allows and even encourages the appropriate use of solar energy systems. This compendium of briefing papers covers a range of specific topics related to planning for solar energy use. Each paper tackles a different aspect of the issue with a special emphasis on how local plans and implementation tools can reduce barriers to local solar market growth.

About the SunShot Solar Outreach Partnership

The U.S. Department of Energy (DOE) SunShot Initiative is a collaborative national effort to dramatically reduce the cost of solar energy before the end of the decade. The SunShot Solar Outreach Partnership (SolarOPs) is a DOE program providing outreach, training, and technical assistance to local governments to help them address key barriers to installing solar energy systems in their communities. The International City/County Management Association (ICMA), American Planning Association (APA), and National Association of Regional Councils (NARC), along with ICLEI-Local Governments for Sustainability and its partners, were competitively selected by DOE to conduct outreach to local governments across the United States, enabling them to replicate successful solar practices and quickly expand local adoption of solar energy. For more information visit the SolarOPs website (solaroutreach.org).

The American Planning Association provides leadership in the development of vital communities by advocating excellence in community planning, promoting education and citizen empowerment, and providing the tools and support necessary to effect positive change.

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Executive Summary

Much of the work that planners do can be summed up under the broad umbrella of "sustainability." Planners are dedicated to creating communities that offer better choices for where and how people work and live for present and future generations. They promote policies and practices that improve equity, economy, and the environment, and help communities to envision their futures, finding the right balance of new development and essential services, environmental protection, and innovative change.

An increasing number of communities recognize energy use as an important piece of the sustainability puzzle. Renewable energy development offers a host of economic and environmental benefits. Solar energy in particular is a safe, clean, and abundant energy resource available to every community for on-site, distributed power generation. Solar panels and hot-water heaters on the rooftops of homes and businesses lower energy bills and provide jobs for system installers and manufacturers. Solar power plants generate electricity without the emissions and pollution associated with fossil fuels. Thoughtful siting and orientation of development, from the street grid to individual buildings, allow for natural, passive assistance for both heating and cooling needs.

While some communities have recognized the potential of solar energy resources to help them save money and improve the environment, many more have yet to do so. As a result, this important energy resource goes untapped, denying residents the ability to lower their energy bills and reduce demands on fossil fuel usage. From a more practical standpoint, local governments across the country have been caught flat-footed by proposals for new solar farms or by a sharp uptick in permit applications for new rooftop solar installations. A conspicuous silence on the part of local policies, plans, and regulations on the topic of solar energy use constitutes a significant barrier to adoption and implementation of these technologies.

The first paper in this compendium addresses the topic of solar community engagement strategies for planners. Involving community members and stakeholders in developing new plans and policies can be an integral step in accurately reflecting the community's goals and priorities and gaining support for implementation. In addition, community outreach and education, especially around emerging issues, is an important role for planners and other local government staff. After introducing these concepts, the paper reviews some common public concerns and misconceptions around solar energy so planners can be better prepared to respond with correct and current information. It also highlights opportunities to raise local awareness about solar energy by helping to create and distribute information materials, such as brochures and website content, and by providing opportunities for public education, including forums and workshops.

A major tool that a growing number of communities are using to both educate residents about the solar resource as well as track local solar implementation is the solar map. The second paper discusses how local governments are using online mapping tools to showcase existing installations and to allow residents and business owners to estimate the solar resource available to their properties and the potential cost savings that installing a solar energy system could offer. Solar maps can also be used to provide information to residents about local installers and financing options, and can help utility companies track their own systems' production and efficiency.

Once solar energy has made it on to the local agenda, it is important that local governments make their solar priorities clear and set the stage for growth in local solar markets. Planners have a big role to play in this step by helping their communities adopt and implement policies and regulations that will help them turn these visions into reality. Local plans, most importantly the comprehensive plan, can help clarify a community's goals when it comes to solar energy, identify the local solar resource, outline relevant policies, and establish the foundation for incorporating solar energy standards into local development regulations. The third paper talks about how planners can help integrate solar goals, policies, and actions into the comprehensive plan while ensuring consistency with other plans, such as energy plans, climate action plans, and sustainability plans.

Planners must also help their communities translate solar plan policies into standards and incentives that enable various types of solar projects. An important part of this process is reviewing and updating local development regulations such as zoning ordinances and subdivision codes to ensure that unintended barriers to solar are removed and appropriate regulations are added. The fourth paper summarizes how planners can help remove barriers and add appropriate standards to local development regulations. It examines the range of solar-related provisions that planners should be knowledgeable about, from the familiar accessory small-scale solar energy systems and principal-use solar energy generating facilities growing in number across the country, to more conceptual and design-oriented considerations such as protections for solar access and solar-oriented site and building design.

But planning doesn't happen in a vacuum. As communities discuss what role solar energy might play in their future and move ahead with solar development, they may run into some unexpected challenges. Planners can lead the way in proactively addressing these challenges and developing solutions that benefit everyone. The fifth paper acknowledges that solar development can come into conflict with other community priorities and goals such as tree conservation, historic preservation, and urban redevelopment. It provides planners with information on how to balance differing community values and minimize conflicts that may arise between solar energy use and other planning initiatives, highlighting relevant legislation, case law, and local development regulations that can help these resources co-exist in the future.

Finally, a major opportunity exists for communities to integrate solar energy facilities into the hearts of the communities with minimal impact while at the same time solving a long-time challenge to community health and development. Brownfields— vacant, often formerly industrial properties whose reuse is complicated by the presence of pollutants or contaminants—as well as other vacant or underused properties offer prime locations for solar installations in cities and towns throughout the country. The sixth and final paper provides a primer for how to promote and pursue reuse of land for local solar energy development. It addresses barriers that may include incomplete or inaccurate information about available sites, inadequate solar access, outdated or confusing development regulations, extensive on-site contamination, and insufficient project financing.

Together, the topics covered in this compendium offer a roadmap for communities and the planners that guide them to bring solar energy into the community conversation, create a policy framework and implementation mechanisms that enable and promote solar energy utilization, and overcome challenges and barriers to making communities more sustainable through taking advantage of this safe, clean, and abundant source of energy.

Solar Community Engagement Strategies for Planners

Planners work to improve the sustainability and livability of their communities. They are uniquely positioned and qualified to promote policies and practices that improve downtowns and neighborhoods, lessen human impacts on the environment, strengthen local economies, and engage community members in analyzing issues, generating visions, developing plans, and monitoring outcomes (Godschalk and Anderson 2012).

Energy use is an important piece of the sustainability puzzle. APA's policy guides on energy and sustainability exhort planners to support energy efficiency, energy conservation, and renewable energy development, including appropriate on-site applications of renewable energy systems along with regulatory and financial support for these technologies (APA 2000, 2004). States, regions, and local communities have also been taking action to promote sustainability and mitigate global climate change by addressing energy use; examples range from state renewable energy portfolio requirements and financial incentives for purchasing renewable energy systems to local plans that address energy use, greenhouse gas emission reduction, and climate change adaptation strategies.

Many communities are looking to solar energy to help them meet energy and sustainability goals. Solar energy is a safe, clean, and abundant energy resource available across the country for decentralized, on-site power generation. Constant improvements in technology and manufacturing processes are driving prices down, putting these systems within reach of more and more citizens. Solar energy reduces dependence on fossil fuels, and the energy produced by photovoltaic (PV) systems can reduce residents' energy bills and ease demand on the power grid. Solar panels can be easily placed on roofs and over surfaces such as parking lots, making productive use of these underutilized spaces; in fact, studies have shown that California's entire renewable energy goal (20 percent by 2030) could be met by solar panels on rooftops, parking lots, and brownfields (Weinrub 2011).

Planners can play an important role in this area by initiating and facilitating community conversations about solar energy. These conversations may be in the context of formal visioning or goal-setting exercises; alternately, questions or concerns about solar energy may rise spontaneously in response to specific development proposals. Planners should also be aware of common public concerns and misconceptions about solar energy and be able to provide correct and current information in response. Further, they can help raise local awareness about solar energy by helping to create and distribute information materials, such as brochures and website content, and by providing opportunities for public education, including forums and workshops. And planners should know which stakeholders and local experts should be involved in the process. This briefing paper will show how planners can initiate a community conversation about solar energy, respond to common solar myths and misconceptions, and better engage and educate community members about solar energy systems.

Initiating a Community Conversation about Solar Energy

Community visioning is the process of identifying collective values and priorities. Communities conduct visioning exercises both in the context of formal planning processes and as stand-alone initiatives. Through visioning and goal-setting exercises, planners have opportunities to initiate community conversations about solar energy, and these exercises give planners chances to highlight both the benefits of and barriers to increasing local solar energy production.

While visioning is an ideal venue for initiating a community conversation about solar energy, planners should also be prepared to facilitate conversations about solar that might arise either in response to a specific development proposal or through some other phase of the planning process. Discussions of policy or project alternatives may segue naturally into a community conversation about solar. When this happens, planners must be prepared to provide complete and accurate information about solar energy and how it connects to other community goals and values.

Common Concerns and Misconceptions about Solar Energy

Though just about everyone can recognize a solar panel when they see it, unfamiliarity with basic information about solar photovoltaic technology, systems, and economics can be a barrier to solar implementation. Lack of understanding of the technology was one of the top five challenges to solar implementation identified by local governments in a 2011 survey (ICMA 2011). It is important that planners be aware of the most common public concerns and misconceptions about solar energy and be reasonably knowledgeable themselves. Planners must actively address these issues in order to remove conceptual barriers from community interest in and acceptance of solar energy—whether answering individual requests for information from citizens interested in installing solar energy systems or responding to skeptics in a hearing or other public forum.

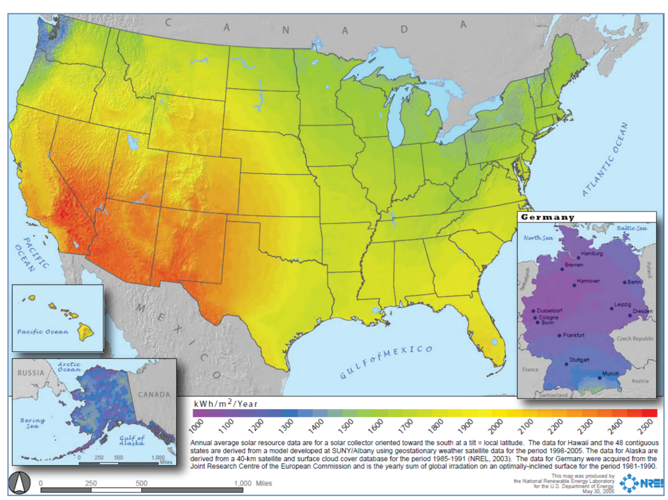
Below is a list of common concerns or misconceptions about solar energy, followed by facts and current research that address these concerns.

Issue: Solar Resource

"It's not sunny enough in our community to support solar energy production."

Some see solar energy as a perfect fit for hot and sunny locales such as California or Arizona, but think that their community is too cloudy or rainy for solar production to make sense. However, every state in the U.S. receives as much, or more, sunlight than Germany, which leads the world in solar PV installation and energy production. On a sunny summer afternoon, solar power can offset up to 50 percent of Germany's total electricity use (Kirschbaum 2012)—and a PV system in Massachusetts will produce 35 percent more annual electricity than its German counterpart (NREL 2012).

Though individual sites vary in the amount of solar insolation they receive due to topography, latitude, and climate, every community in the U.S. receives enough annual solar radiation to make solar a viable energy option. For example, Minneapolis receives 90 percent of the incoming sunlight that Miami sees each year, despite the differences in climate between these locations. Additionally, solar collectors still produce energy in cloudy or overcast conditions, with the panels working more efficiently in the cooler temperatures. According to NREL's PVWatts solar resource calculator, a 4-kW PV system in Seattle produces more than half of the power of that same system on a Phoenix rooftop—which is still enough to power over half of a typical home's annual energy needs (NREL 2012).



Most of the U.S. receives more solar resource each year than Germany, the world leader in installed solar capacity. (Image credit: NREL)

Issue: Cost

“Solar is too expensive to consider installing a system on my home.”

Many people support the idea of solar energy production and would love to have their own solar energy systems working away on sunny days but think that the high upfront capital costs of PV panels put solar energy out of reach. Indeed, respondents to the 2011 solar survey identified the high cost of solar as the most significant challenge to solar implementation (ICMA 2011). It is true that solar energy systems are expensive. However, no source of energy is free, and thanks to improvements in manufacturing processes and economies of scale, the cost of solar has been dropping rapidly over the last few years. The installed cost of solar has dropped from $11 per watt in 1998 to less than $4 per watt in 2011, with costs falling 36 percent between 2010 and 2011 alone (Barbose et al. 2011; SEIA and GTM Research 2011). In Hawaii, the cost of solar already equals that of other energy sources at current electricity prices (“grid parity”), and by 2020 this is expected to be true for many places across the rest of the U.S. (Denholm et al. 2009).

For homeowners installing their own PV systems, the payback period for their investments is falling and in some states can be as little as five to seven years. In some cases, a solar lease or power purchase agreement (PPA) can make a solar system cash-flow positive in the first month. In addition, the longevity of solar PV systems—many are now being warrantied for 25 years or more, and most continue to function well long past this point—ensure that homeowners will continue to recoup their initial investment in reduced energy bills and savings for many years after their systems have paid for themselves. In addition, solar systems can add value to homes. Online calculators, such as the Sandia National Labs PV Value Tool, allow homeowners or appraisers to assess the value of solar systems on properties; studies have shown that energy-efficient homes with PV systems gained value faster and sold more quickly than equivalent nonsolar homes in California, with average sale premiums of around $17,000 for a home with an “average-sized” 3.1-kW PV system (Farhar and Coburn 2006; Hoen et al. 2011).

Finally, a range of financial incentives available from federal, state, and local governments, as well as utilities, are helping to level the playing field for solar and offset the initial up-front costs of PV systems. These include grants, rebates, low-interest loans, and tax credits (DSIRE 2012). Some communities have established “Solarize” neighborhood collective purchasing programs for residents, which lower upfront costs, reduce complexity, and motivate consumers to act (Irvine et al. 2012). And for those who do not have the resources to purchase their own solar systems, third-party financing arrangements including leases and power purchase agreements (PPAs), in which the homeowner does not own the PV system but gets the benefits of a discounted electricity rate, are becoming more popular and increasingly dominant in markets where policies and rules allow for these options (Wesoff 2012). And cooperative “solar farms” are cropping up as well, in which consumers purchase “shares” in a centralized solar energy facility entitling them to credits for a percentage of the electricity generated by the facility each month. One such example is the Brewster Community Solar Garden Project in Massachusetts, a 1440-panel, 345.6-kW array located on a former sandpit owned by the Brewster Water Department; through “virtual net metering” each shareholder receives monthly credits equal to the energy output of 28 panels (Brewster Community Solar Garden Cooperative 2012).

Issue: Technology

“Solar technology is still improving; it’s better to wait a few years and install a more advanced system.”

As discussed above, the solar industry is making steady improvements in its manufacturing processes, which is helping to drive costs ever lower. But unlike iPods or computers, the basic product of PV technology itself—the delivery of electrons—has not changed and will not change in the future. In addition, PV is a modular and expandable technology that allows for the addition or replacement of existing systems with new equipment if desired. While prices of PV equipment will most likely continue to fall and efficiencies will continue to increase, if solar makes economic sense today there is no reason to wait to install a system.

Issue: Glare

“Glare from solar panels could be annoying to my neighbors or dangerous to drivers.”

The aesthetics of solar panels may raise concern for some residents, and one aesthetic aspect of PV that could shade into the area of nuisance is the potential for glare. However, solar panels are designed to absorb radiation, not reflect it: constructed of dark-colored materials and covered with anti-reflective coatings, today's typical solar panels reflect as little as 2 percent of incoming sunlight. In addition, individual projects can be analyzed and adjusted to mitigate potential glare issues. A number of solar installations have been successfully located at or near several U.S. airports (including Boston, New York, San Francisco, and Denver), where glare is of paramount concern, and evidence thus far suggests that glare has not been a problem for airport personnel in these instances (FAA 2010).

Issue: Economic Viability

"Solar isn't worth pursuing. It needs too many subsidies to compete with other energy sources, and companies keep going bankrupt."

Renewable energy production, both from wind and solar, has been boosted in the past several years by financial incentives at both the federal and state levels, which may lead to a conception that renewable fuels are not economically feasible energy sources compared to traditional fossil fuels. However, closer examination reveals that not only has oil and gas production been the recipient of significantly more financial subsidies than renewables—an annual average of $4.86 billion for the former versus $37 million for the latter—the petroleum industry has been receiving those subsidies since 1918, compared to 1994 for renewable energy (Pfund and Healey 2011). In addition, subsidies for oil and gas production are stable compared to those for wind and solar energy, which have not remained constant or predictable since their inception, resulting in a much more unpredictable market. Indeed, current solar federal incentives are slated to expire in 2016, while fossil fuel subsidies are set to remain intact. Despite these comparative shortcomings in economic support for solar energy, the cost per watt of this energy source is dropping, as noted above, and solar is expected to equal the cost of other electricity sources even without subsidies by 2020.

Likewise, despite the much-hyped bankruptcy of solar manufacturing companies such as Solyndra in 2011, data shows solar as a whole to be a robust and growing industry, with a 28 percent expansion in U.S. manufacturing capacity in 2011. Further, the U.S. saw a 109 percent growth in PV installations in 2011, and these trends are expected to continue (SEIA and GTM Research 2012).

Issue: Environmental Impacts

"Solar panels are manufactured with toxic metals that could contaminate installation sites and pollute landfills if discarded."

Though solar technology and manufacturing may be complex, solar panel composition is fairly simple: most panels are constructed of glass (silicon), with common metals such as aluminum and copper wiring, and don't tend to contain heavy metals or other potentially toxic substances. The one exception is thin-film solar products, which may contain heavy metals. Because few solar panels contain toxic chemicals, they pose little threat of site contamination. And when panels reach the end of their productive lives, they can be broken down into their component parts and recycled. More than 90 percent of a PV module can be recycled; 80 percent of that is glass, with the remainder metals (including silver and aluminum), plastic components, and semiconductors. Furthermore, a number of manufacturers offer voluntary panel take-back programs (Sniderman 2012). Like all manufactured products, the production of solar panels does cost energy—however, studies show that the panels' energy production more than pays off the energy cost of their manufacture, with energy-cost paybacks of less than two years (Sanchez 2008).

Issue: Values

"Solar is only for environmentalists."

Solar energy—and renewable energy in general—is an important source of clean energy and a key strategy for reducing greenhouse gas emissions and mitigating climate change. However, solar is not just for environmentalists. There are a number of other benefits to solar besides "being green"—primarily, saving money on electricity costs. Once solar panels are installed, they will provide a source of free energy for decades with minimal maintenance costs, translating into substantial savings on electricity bills. Municipalities across the country are adding solar PV to city buildings, parking lots, and other structures to help reduce their energy bills for building and plant operations over the long term. For example, a 1-MW solar array installed in 2012 by California's Santa Barbara County at its Camino Real campus, which houses its jail, sheriff's department, three public hospitals, and several administrative offices, is expected to offset one-third of the facility's annual energy use, saving the county $12 million over the life of the system (Solar World 2012). The U.S military is heavily investing in rooftop solar to power facilities and reduce dependence on costly foreign oil, and local emergency service providers are adding solar facilities to provide alternative sources of power for operations. Even NASCAR is joining the solar movement—it has installed a solar array at its Pocono track in Pennsylvania that will be able to power that entire facility, along with 1,000 homes.

Research and experience is proving that solar is a safe and abundant source of clean energy. Apart from ensuring that local plans and development regulations allow residents to easily install approved solar energy systems in appropriate contexts and locations, planners can help communities tap into this resource by providing current and accurate information on solar energy to the public and addressing any concerns that may be voiced.

Strategies for Community Engagement

One of planners' main roles is to make sure that local residents have access to reliable information about planning issues and other topics of interest. Besides simply being repositories of information on solar energy, planners are in a position to educate and inform their communities about the general benefits of solar, as well as promote solar-related goals and policies their local governments have adopted or solar programs they may be offering. There is a need for public education and outreach around solar energy; "lack of interest in or awareness of solar energy development" was the third most commonly reported challenge in the 2011 solar survey (ICMA 2011).

Planners can assist with local solar efforts by developing materials about and conduits for information on solar technology, policies, and programs to help educate the public, as well as facilitate hands-on opportunities for residents to learn more about solar energy. There are a number of tools and strategies planners can use.

Solar Fact Sheets, Brochures, or Guides

Planners can help develop solar fact sheets, brochures, or guides on a number of helpful subjects, including the benefits of solar energy; answers to common questions and concerns (see above); local solar visions, goals, policies, and programs; the specifics of local solar regulation and permitting; and federal, state, or local incentives.

For example, Seattle's Department of Planning and Development has created a Client Assistance Memo on solar energy system permitting, which describes solar PV and hot water systems and outlines permitting and land-use requirements, design and installation standards, contractor selection considerations, and financial incentives. Similarly, the Bureau of Development Services in Portland, Oregon, offers detailed program guides for residential dwellings as well as commercial buildings that define solar PV and water heating systems and provide information on installation, permitting, and inspection requirements. In lieu of creating new documents, planners can also help connect residents to existing material, such as the information resources available through the SunShot Initiative at www1.eere.energy.gov/solar/sunshot/resources.html.

Solar Maps

Planners can help guide the development of a solar mapping application for their community. A number of local governments have developed interactive online maps that track solar installations within their jurisdictions and allow residents to determine the solar potential of their home or property. For example, San Francisco's solar map highlights existing solar PV and water heating installations in the city (identifying locations, system sizes, and installers) and allows users to enter a city address to find a property's solar electric and water heating potential. The second briefing paper in this series, "Solar Mapping," provides more information on this educational tool.

Solar Websites

Planners can create online, one-stop information portals for solar energy for residents in their community. These sites can provide links to solar information resources; local policies, regulations, and permitting information; a calendar of events for solar workshops or educational events (see next section); profiles of and contact information for local solar installers; or information on local demonstration projects.

For example, Knoxville, Tennessee, a 2008 Solar America Communities city, designed their solar energy website, www.solarknoxville.org, to be a "one-stop shop for citizens, business owners, and students wishing to learn more about solar energy and how it can be used in our community." It provides basic information about solar PV and water heating systems, links to local installers, a list of exemplary local solar installations, and local events, workshops, and solar tours. The City of San Jose, California, offers a one-stop shop website that lists the city's Green Vision and solar goals; describes the benefits of solar energy and different types of solar technology; lists financing incentives and permitting requirements; and provides additional solar resources and information.

Local Solar Recognition Programs

In order to raise awareness and promote pride in local solar energy installations, planners can develop local recognition or awards programs for solar energy systems. The City of Santa Barbara, California, adopted solar design guidelines and created a recognition program in 2006 as part of the city's participation in the federal Million Solar Roofs program. Both passive and active solar projects that are completed in compliance with the city's Solar Energy Systems Design Guidelines are considered "Sustainable Santa Barbara" leadership solar projects eligible for annual awards in several categories, including "Design Challenge" projects that are publicly visible and "Special Challenge" projects on Mission-style tile roofs or on historic structures. By 2011, the city had seen at least 426 systems installed, with more than 140 systems pending installation.

Solar Workshops

Planners can help organize public workshops about solar energy and implementation. Apart from providing information about solar energy systems directly to participants, workshops provide an opportunity for meaningful public dialogue about solar myths, misconceptions, and local concerns. These discussions can help planners identify barriers to and strategies for adoption and acceptance of solar energy. Possible partners include industry groups, nonprofits, and educators.

For example, Portland's Solar Now! Program has teamed up with the outreach and education nonprofit Solar Oregon to connect local residents to a range of public workshops for both residential and commercial solar applications. Similarly, Seattle's publicly owned electric power utility, Seattle City Light, partnered with Northwest SEED, a sustainable energy nonprofit, to offer free "Solar Works in Seattle!" workshops over a period of 12 months at Seattle Department of Parks and Recreation community facilities throughout the city. Workshops covered the basics of solar electric and hot water systems, as well as more in-depth views of the technologies and installation processes, and reached an estimated 500 residents (U.S. DOE EERE 2011c).

Solar Curriculums

Planners can work with organizations and educators to develop and promote teaching units about solar energy. This offers important opportunities to instill interest and excitement about renewable energy sources and sustainability in younger generations. The City of Austin, Texas, worked with science coordinators and curriculum directors from the Austin Independent School District to develop hands-on learning curriculum materials designed to be used in conjunction with PV installations at local schools (U.S. DOE EERE 2011a). The city has 13 PV installations at local schools and community colleges that feature web-based monitoring systems, allowing students to monitor the performances of systems at their schools and compare them to those at other schools.

Solar Demonstration Projects

A number of municipalities are installing solar installations on public buildings to both cut energy use and costs and promote sustainability principles and practices. Planners can help coordinate the use of these installations as teaching tools through educational and outreach elements, such as information kiosks at installation sites, real-time online tracking of power generation on the city solar website, and tours of installation facilities. Many private-sector corporations and organizations are also installing solar energy systems as part of their facilities for much the same reasons, and planners can work with these entities to coordinate similar educational opportunities.

For example, the City of Bellingham, Washington, installed a 12-panel, 2-kW solar PV system on the roof of its Environmental Learning Center at Maritime Heritage Park, in partnership with Puget Sound Energy's Green Power Program and the Bonneville Environmental Foundation. An interactive kiosk details the real-time and historical performance of the system and visually depicts how solar energy is generated; the kiosk will later be moved to Bellingham's city hall. As another example, in 2009, the Township of Hardyston, New Jersey, installed a 75-kW PV array on a solar support structure that doubles as a carport for police vehicle parking, which meets about 30 percent of the municipal complex's annual energy needs and is projected to save the township $1.5 million over a 15-year period. A web-

One Community's Experience: Salt Lake City, Salt Lake County, and Utah Clean Energy Opening the Door to Solar Energy

In 2007 Salt Lake City and Salt Lake County, Utah, established a goal to achieve 10 MW of solar PV installed by 2015. At the time they had virtually none of the foundational pro-solar policies, rules, and incentives in place in surrounding states. What's more, community stakeholders had limited exposure to solar energy, which translated to limited awareness and understanding of solar technologies and applications. Undaunted by the formidable task at hand, the city and county joined forces with a trusted local nonprofit, Utah Clean Energy, and other partners to tackle the barriers to solar one by one. Their strategic public-private initiative, known as the Solar Salt Lake Partnership (SSLP), laid the foundation for significant solar market growth. Five years after Salt Lake City was named one of the U.S. Department of Energy's first thirteen Solar America Cities in 2007, the installed rooftop solar PV capacity in the city and county has increased nearly 4,000 percent, growing from a nominal 158 kW to nearly 6,500 kW in 2011. In recognition of their successes and their ability to build bridges from brick walls, the SSLP has received "Barrier Buster" and "Mountain Mover" awards from the U.S. Department of Energy.

Instrumental to the success of the SSLP was a concerted focus on community engagement and outreach to diverse stakeholders, including utilities, regulators, policymakers, planning and zoning officials, building officials, businesses, citizens, and solar installers. As manager of the SSLP, Utah Clean Energy worked closely with the city and county to implement several of the following community engagement strategies, which helped garner broad support for solar and eliminate roadblocks to solar energy:

- Solar workshops with well over 100 stakeholders to inform the development of Powering Our Future: Solar Salt Lake Implementation Plan, a toolbox for elected officials, government agencies, and affiliated partners to grow the local solar market
- A solar mapping website with calculator, developed by the city's GIS specialists and IT consultant Critigen, to help local citizens better understand their solar resource potential
- A brief billboard and media campaign to direct people to the solar mapping website and implementation plan

Billboard from the Solar Salt Lake Partnership's solar campaign. (Image courtesy of Utah Clean Energy)

- Solar Code Trainings with solar code experts to educate building and permitting officials about solar technologies, facilitating easier permitting of solar projects
- Peer-to-peer and community forums and workshops, through the city's Sustainable Code Revision Project with Clarion Associates, to review and develop new solar-friendly zoning ordinances, which the city ultimately adopted
- Strategic collaborations with businesses and citizens to garner support among key decision makers for a state law enabling third-party power purchase agreements (PPA) for Utah's governments, schools, and churches
- Engagement with over 100 stakeholders in the utility regulatory arena to increase the allowable interconnected solar project size from 25 kW to 2 MW and give fair value to excess solar generation

While major strides have been made on the solar front and the solar market continues to expand, Salt Lake City, Salt Lake County, and Utah Clean Energy remain steadfast in their efforts to unlock the local solar market. As part of U.S. DOE's Rooftop Solar Challenge, the three partners have united with four other local governments to tackle solar permitting, financing, and solar zoning.

Sara Baldwin, Utah Clean Energy

site tracks the system's energy production, and the township installed a monitor screen in the local middle school as an educational tool for students.

Partnerships with Experts

Planners can't do all of this work alone; in many cases, planners and municipal governments do not have the expertise, the time, or the resources to provide solar energy information or education. Many cities and counties have developed relationships with local experts in solar energy to help promote solar awareness in their communities—from hiring consultants to partnering with nonprofits, local industry professionals, or educators to provide information or educational opportunities on solar energy systems.

To illustrate, the city of Berkeley, California, has partnered with local nonprofit Community Energy Services Corporation (CESC) to provide free, independent energy education and site-specific installation advice for residents and businesses. As part of the partnership, CESC will walk homeowners and businesses through the solar energy system planning and installation process. CESC also offers free energy efficiency and solar potential assessments of individual properties, maintains a preapproved vendor list of solar installers, and will assist residents in analyzing and choosing the best project bid from those vendors. Similarly, the city of Madison, Wisconsin, hired a Midwest Renewable Energy Association–certified consultant through 2012 to act as a "solar agent" for home and business owners. The prospective solar owner agent (PSOA) performed free site surveys for interested residents, and if the property received a favorable rating, the agent arranged an on-site assessment, prepared a financial assessment of the potential system, and helped the resident gather and compare quotes from local solar contractors (U.S. DOE EERE 2011b).

Conclusion

Energy use is an important issue for communities to address both for environmental and economic reasons. Renewable energy is an important piece of the energy puzzle, and solar energy is a promising resource that municipalities and their residents can tap into to reduce energy costs, greenhouse gas production, and dependence on fossil fuels and foreign sources of oil. Planners can help their communities meet their solar energy visions and accomplish implementation items by ensuring that residents know the facts about solar energy and are aware of local programs and goals. By becoming knowledgeable about common solar energy concerns and by using a variety of strategies and tools for increasing public awareness, planners can help their communities move toward greater sustainability.

This solar briefing paper was written by Ann Dillemuth, AICP, Research Associate at the American Planning Association, with assistance from Sara Baldwin, Senior Policy and Regulatory Associate at Utah Clean Energy, and Chad Laurent, Senior Consultant, Meister Consultants Group.

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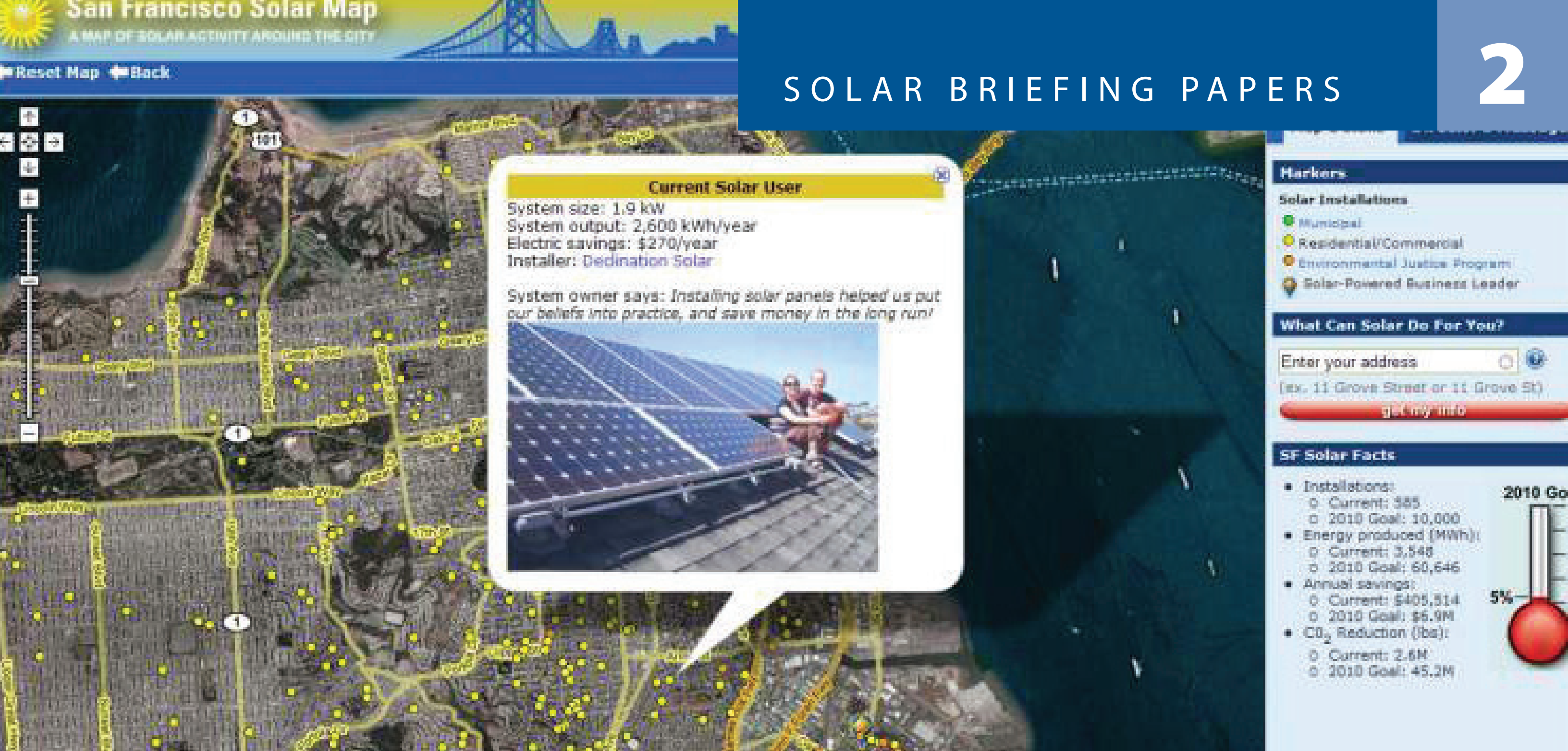
Cover: The Brewster Community Solar Garden, Brewster, Massachusetts. *(Image courtesy of www.brewstercommunitysolar-garden.com.)*



Solar Mapping

Planners and the communities they serve are increasingly recognizing the importance of sustainable places. A critical aspect of helping cities improve their environmental and economic performances over the long term is supporting their transitions to cleaner fuel sources to reduce greenhouse gas emissions and improve energy security. A growing number of communities are discovering that the use and integration of solar energy can play an important role in helping them reach their sustainability goals.

Most people support renewable energy efforts in theory, but they may fail to act individually because of the uncertainties associated with installing solar energy systems. Most property owners are unaware of how much solar power potential exists on their building rooftops, where other systems have been installed in the area (and by whom), how much an installation will cost, and how cost-effective it can be in relation to their energy bills. Solar maps are innovative tools that can provide easy answers to these questions. They can help inform policy decisions, educate consumers, drive technological development, increase manufacturing capacity, and improve marketing methods. This briefing paper explains what solar maps are, how they work, and how communities can benefit from their use.

What Is a Solar Map?

A solar map is an internet-based tool that helps educate and inform users about solar technology by estimating the solar energy potential of building sites or open land and providing information about associated benefits. The purpose of a solar map is to promote greater public awareness about solar energy, enable consumers to discover the solar potential of their own properties, and facilitate increased solar usage among property owners.

Benefits of Using Solar Maps

A solar map can serve as a single place to store complete information on solar resources. Like the concept of a "one-stop shop" for permitting, solar map portals can store all federal, state, and local information regarding available solar incentives and programs. Solar maps are user-friendly, allowing users to make quick and easy assessments of the solar potential of their properties. When given minimal information such as a street address, the map can instantaneously generate data about potential costs, potential cost savings through incentives and rebates, and energy usage for that property. Additionally, solar maps are interactive. They can include tools to draw potential PV-system layouts or estimate shading from nearby structures or vegetation, providing a level of detail that allows users to assess an open space on a specific property or rooftop and take into account any obstructions that reduce usable area for panel placement. Finally, solar maps generate quantifiable outputs that can inform decisions made by government officials and the general public.

Users and Types of Solar Maps

Solar maps can be used by a variety of audiences. Local government officials (such as mayors, economic development directors, and planners) can use solar maps to track progress toward achieving sustainability goals stated in comprehensive plans, sustainability plans, or renewable energy plans. Solar maps can help communities run scenarios to determine anticipated outcomes and track completed installations to measure success in real time. In Santa Clara County, California, for example, solar mapping allowed government officials to estimate the effect that 10 potential solar-installation target areas would have on the county's CO_2 emissions. San Francisco's solar map displays citywide solar statistics including the amount of solar energy produced, annual cost savings, and reductions in CO_2. These figures help hold the city accountable to its residents and are used to gauge progress toward meeting established city goals. Planners can use solar maps to identify high-installation areas in the city and use those numbers to inform economic development or green job training efforts.

Installers may use solar maps to understand how use of solar technology has grown over time and determine where they should focus their business efforts. They can advertise their services or showcase their installations on solar maps. Additionally, they can extract data to use in strategic marketing and outreach efforts. Los Angeles County's solar map provides a list of tips for installers on how to make the most of the information solar maps can provide, including suggestions that installers use map data to develop targeted mailing lists for properties with high solar potential, target high-value properties, or develop return on investment (ROI) models for potential customers.

Utility providers can use solar maps to visualize the distribution of projects within their territory, gauge future distribution congestion issues, determine particular neighborhoods or regions with customer interest in solar, determine the rates at which local markets are developing, and estimate the anticipated reduction in customer demand for more traditional sources of energy in their service territories.

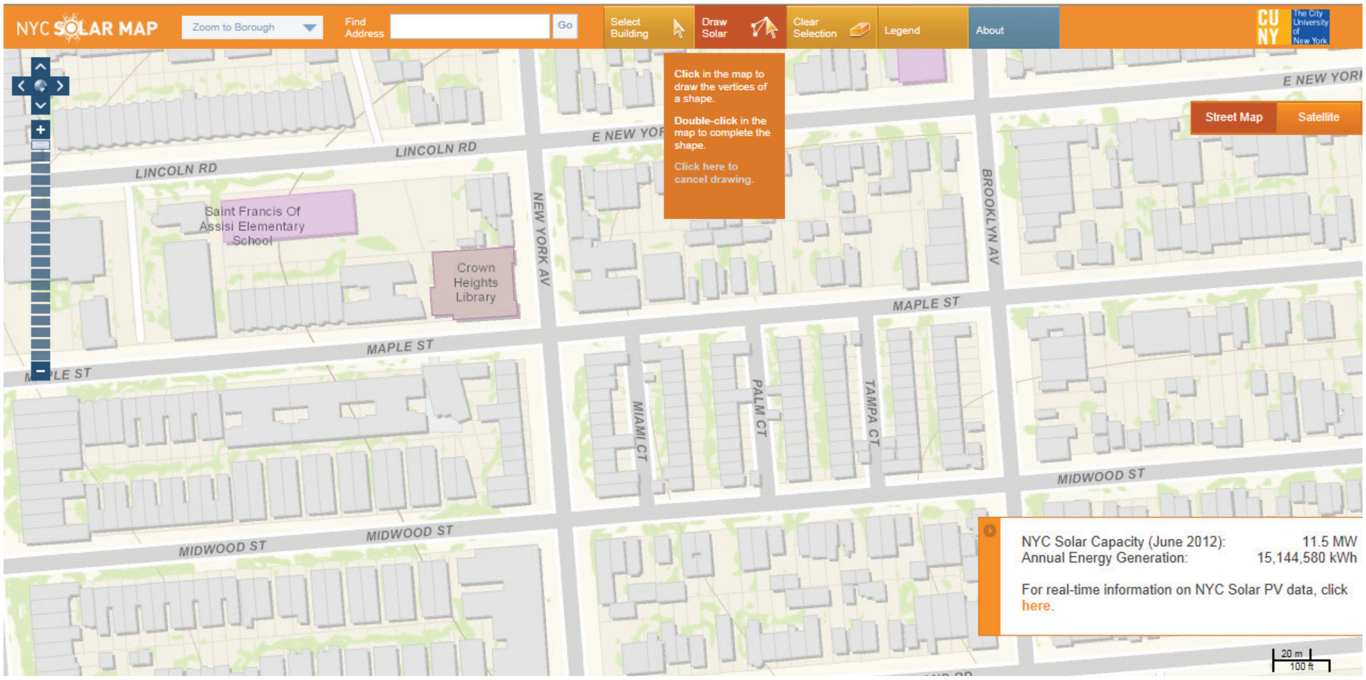
Homeowners and business owners can use solar maps to research the solar power potential of their homes or businesses. They can educate themselves on the costs of installation, financing options, potential energy savings, payback times, maintenance requirements, life expectancies, and other factors. They can discover which neighbors have installed PV panels on their property, the sizes of the systems installed, and the amount of energy the panels are producing. This is powerful information in terms of behavior change and competition, which drives the market for renewables in the residential arena. Property owners can also use solar maps to research local installers or arrange for estimates. Solar maps enable property owners to do start-to-finish assessments of the solar potential of their properties—from investigation to education to action.

Solar maps can be used for projects of all sizes and can be customized to produce outputs that meet the needs of their users. If a city wants to measure its progress toward achieving sustainability goals, then its solar map needs to provide data at a city-wide level. In other instances, municipalities may want to determine the solar potential of more narrowly defined areas of the city, such as commercial and industrial buildings over 50,000 square feet, designated residential "solar neighborhoods," or specific economic corridors. Alternatively, the city might identify what it believes to be ideal locations for solar (such as highway interchanges, municipal buildings, or large industrial buildings) and want to see what effects installing solar in these locations would have on reducing energy costs and emissions. Further still, cities might use solar maps to determine the best locations for solar installations in the city.

Components of a Solar Map

A community can choose to incorporate a wide range of information into its solar map, but three levels of basic input data are needed to begin: topographic data, meteorological data, and financial data (Dean et al. 2009).

The most accurate form of topographical data is Light Detection and Ranging data (LiDAR). LiDAR data can be used to create three-dimensional digital elevation models (DEMs) that analyze the impacts of shading obstructions, identify roof tilt, and estimate the amount of roof area that can used for a particular installation (Dean et al. 2009). Although LiDAR provides the greatest degree of accuracy, it is also a significant expense for communities. Where LiDAR data are not available, a community can use high-resolution orthophotography along with building footprint and parcel data for feature and building identification. Many of these datasets are already available within city governments.



The Draw Solar tool in New York City's solar map allows users to draw a solar installation and immediately generate information on the installation including cost, financial metrics, electricity bill savings, environmental impacts, and available incentives. (Image courtesy of http://nycsolarmap.org/)

The second layer, meteorological data, is used to estimate the solar resource at a given site. This accounts for spatial and temporal variations in solar radiation and ultimately identifies how much solar resource is available for solar PV systems. Some maps make simplifying assumptions to calculate an annual solar resource estimate; for example, the City of San Francisco's solar map model uses an average of four hours of sunlight per day, while San Jose's assumes six hours. Other maps use hourly meteorological data that are derived from ground-based meteorological stations or satellite-derived meteorological data (Dean et al. 2009).

The third layer, financial and incentive data, is used to calculate the economics associated with a given installation. Typical data incorporated into map models include electricity rates, electricity escalation rates, and installed costs. Communities may also provide information on federal tax credits as well as state, local, or utility incentives (Dean et al. 2009).

Communities may choose to go beyond these three levels to include additional features that allow the map to serve as an all-encompassing source of clean energy information in their city. Additional features may include records on existing systems, links to local installers, photo galleries, news stories, case studies, information on permitting processes and capturing local incentives, schedules of local solar educational offerings, and general information about clean energy technologies.

Solar maps can provide answers to many questions property owners have about the solar potential of their properties. By typing in an address, a resident or business owner can estimate the amount of total roof area suitable for solar, potential system size, potential annual energy output, potential cost savings, and potential annual emissions reductions. Factors such as system type, energy costs, system payback, available incentives and rebates, and installation costs can be incorporated into the model as assumptions. Useful resources include the Database of State Incentives for Renewables and Efficiency (DSIRE; www.dsireusa.org), a clearinghouse for information on federal, state, and local solar incentives, and tools such as the Clean Power Estimator (www.gosolarcalifornia.org/tools/clean_power_estimator.php), which calculates the potential costs and benefits of installing a PV system at a residence or business. Cities can also customize their maps by providing links to local resources or using data obtained from local sources, such as energy costs from local utility providers and system types and installation costs from local installers. But creators and users of maps should note that the information obtained from a solar map is only as good as its data; if the data are not accurate, neither is the information being fed through the solar map.

Some of the more advanced maps, like those of Salt Lake City or New York, offer interactive drawing tools that allow users to manually draw in an installation wherever they choose. This increases accuracy because the user can depict a more exact size of the potential installation and account for objects on the roof, such as HVAC systems or skylights, that might prohibit the placement of an installation. Additionally, users can consider multiple scenarios, such as comparing savings of an installation placed on a garage to one on a roof. Another city with an interactive solar map is Portland, Oregon. Its solar map has a shading slide tool that enables users to estimate the percentage of shade cast on their properties from trees and vegetation.

Finally, in most cities, when a property owner fills out a form to obtain solar incentives, the property is automatically registered and displayed on the solar map along with information such as system size, installation company, and energy output. The owner may choose to provide extra information like a quote about solar or a photo of their installation. Residents can use this information to determine which installers have experience in the local area. Government officials use this information to provide details on their solar programs, including the total number of solar systems currently installed, how much energy these systems are producing, how much money property owners are saving on their utility bills, and how much CO_2 is being offset by these installations. The information can also be used to track progress toward meeting solar installation goals. For example, the City of San Francisco is using its solar map to gauge progress toward reaching the former mayor's goal of having solar PV or solar thermal installed on 10,000 roofs by the end of 2012.

Developing and Maintaining a Solar Map

Solar maps can be created either by city staff or by consultants. A municipality considering developing a solar map in house should evaluate the qualifications of the staff on hand.

A handful of different technologies and methodologies are currently being used to create solar maps. Some cities have used ESRI's ArcGIS Server as their base system and supplemented it with applications such as ESRI's solar analyst extension or with 3D-modeling software to create more detailed analyses. Another technology commonly used in the western U.S. is the Solar Automated Feature Extraction (SAFE™) methodology, currently under patent by CH2M HILL/Critigen. SAFE™ assesses the solar potential of buildings through a combination of aerial imagery and advanced 3D modeling. The method takes into account factors such as roof obstructions (air conditioning units, chimneys, vents), azimuth (the direction of the sun), shadowing from other buildings, and roof slants. This methodology also calculates total roof area, usable roof area for solar panels, the amount of electricity the panels can produce, the electricity cost reduction, and resulting CO_2 reduction. Other companies are beginning to develop solar maps through the use of open-source software programming.

Regardless of who is making the map and what technology is being utilized, many stakeholders should be at the table when the map is being developed. Utility providers can provide information on utility rates and who is currently utilizing solar energy. Solar installers can provide information on installation costs and available resource guides. Local government officials can offer information on permitting processes and community goals. Other solar advocates in the community can provide information on local resources, including available solar educational offerings and meetings.

The amount of time needed to create a solar map will vary based on geography and staff qualifications. If developing a map in house, communities should consider whether staff can make a full-time commitment to development of the solar map. Communities should factor in at least three months for stakeholder coordination and an additional three to six months to develop the map once all of the input data has been collected. The cost to produce a map varies, depending on data quality and availability, area size, and desired level of map detail, and can range from $20,000 to $200,000 (McDermott 2008).

Once a city has created a map, it must maintain the map to ensure accuracy. If a city develops its solar map in house, city staff will likely be responsible for map maintenance. Communities who hire consultants to create their maps can be trained to undertake updates or can continue to contract with those companies to maintain the maps. Most communities update their maps on a quarterly basis, but updates can take place as frequently as monthly or as infrequently as annually. Communities that do not undertake regular updates to their solar maps run the risk of providing outdated data, broken links, and inaccurate depictions of the prevalence of solar in their communities.

Communities with Solar Mapping Tools

Anaheim, California: *Anaheim Solar Map*
http://anaheim.solarmap.org/

Berkeley, California: *Berkeley SolarMap*
http://berkeley.solarmap.org/solarmap_v4.html

Boston, Massachusetts: *Solar Boston*
http://gis.cityofboston.gov/solarboston/

Cambridge, Massachusetts: *Solar Tool v.2.*
http://cambridgema.gov/solar/

Denver, Colorado: *Denver Regional Solar Map*
http://solarmap.drcog.org/

Los Angeles County, California: *Los Angeles County Solar Map*
http://solarmap.lacounty.gov/

Madison, Wisconsin: *Solar Energy Project (MadiSUN)*
http://solarmap.cityofmadison.com/madisun/

Milwaukee, Wisconsin: *Milwaukee Solar Map*
http://city.milwaukee.gov/milwaukeeshines/Map.htm

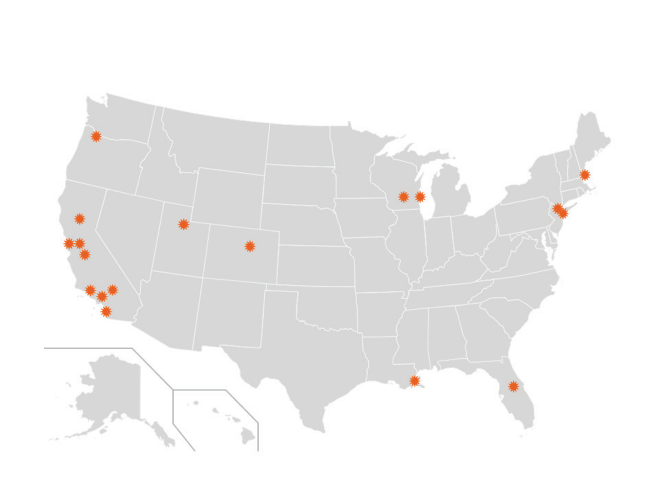
New Orleans, Louisiana: *New Orleans Solar Calculator*
http://neworleanssolarmap.org/

New York, New York: *New York City Solar Map*
http://nycsolarmap.com/

Orlando, Florida: *Metro Orlando Solar Map*
http://gis.ouc.com/solarmap/index.html

Portland, Oregon: *Oregon Clean Energy Map* (forthcoming)
http://oregon.cleanenergymap.com/

Riverside, California: *Green Riverside Green Map*
www.greenriverside.com/Green-Map-9



Sacramento, California: *Solar Sacramento*
http://smud.solarmap.org/

Salt Lake City, Utah: *Salt Lake City Solar Map*
www.slcgovsolar.com/

Santa Clara County, California: *Silicon Valley Energy Map*
www.svenergymap.org/

San Diego, California: *San Diego Solar Map*
http://sd.solarmap.org/

San Francisco, California: *San Francisco Solar Map*
http://sfenergymap.org/

Tallahassee, Florida: *Solar Interactive Map*
www.talgov.com/you/you-learn-utilities-electric-solar-map.aspx

Users should be aware of the assumptions that go into making a solar map. Although maps may be highly accurate, 100 percent accuracy cannot be guaranteed. All information generated by a solar map should be considered an initial assessment that helps the user decide whether to proceed with a solar installation or not. All information and values obtained from a solar map should be verified before moving forward with an installation. Communities should make sure to include disclaimers to this effect on their solar maps.

Solar Map Successes

San Francisco created the first municipal solar map in 2008. Since then, at least 18 additional U.S. cities have created online solar maps to share local solar information with their constituents; see sidebar on p. 5 for more information on these maps.

In the two years after San Francisco's map came online, the city saw PV installations grow by 60 percent and the amount of solar electricity generated in the city doubled. The city has even used its own solar-mapping platform to help install municipal solar systems, including California's largest PV system with 25,000 panels generating about 5 MW (Leitelt 2010).

The City of San Diego is using its solar map to gauge progress toward its goal of having 5 MW of solar power installed on city buildings by 2013 and is tracking the energy production of

Case Study: New York City's Solar Map

Sustainable CUNY of the City University of New York heads the NYC Solar America City Partnership comprising CUNY, the Mayor's Office of Long Term Planning and Sustainability, and the New York City Economic Development Corporation, with the support of multiple other stakeholders through the NYC Solar America City Advisory Board.

Sustainable CUNY, on behalf of the city, has won three consecutive Department of Energy (DOE) grants (2007, 2009, 2012). A portion of the second grant was used to design and build the NYC Solar Map, the largest LiDAR-based solar map in the world. The NYC Solar Map supports PlaNYC goals to foster the market for renewable energy, which is part of the overarching mission to achieve a 30 percent reduction in greenhouse gas (GHG) emissions from 2005 levels by 2030. Additional funding to develop the solar map was provided by the City of New York and the New York State Energy Research and Development Authority (NYSERDA), with technical support provided by Con-Edison. The map was built in the Center for Advanced Research of Spatial Information (CARSI) at CUNY's Hunter College, with computational assistance by the High Performance Computing Center at CUNY's College of Staten Island.

Work on the solar map began in April 2010 when the City provided funds for the collection of LiDAR data by the Sanborn Map Company. Fifteen billion points of data were collected via nine post-midnight airplane flights across the city. The NYC Solar Map, which took about fourteen months to develop, was unveiled by the NYC Solar America City Partnership during the 5th annual NYC Solar Summit on June 16, 2011. The map cost $210,000 to produce, with an additional $450,000 to collect the LiDAR data.

The solar map was completely custom built by hand—no templates were used in its development. It was designed to automatically add additional systems once they are uploaded and approved. Periodic updates, including text changes to the map or changes in assumptions, are handled by CARSI and Sustainable CUNY.

The solar map offers an exceptional amount of detail, providing building-specific information for over one million structures, and was designed to be as interactive and user-friendly as possible. It includes a drawing tool that allows the user to pencil in proposed installations on his or her property and compare differences in costs and energy savings of different location options. The map also incorporates a shading algorithm that considers both vegetation and buildings as well as city regulations including zoning and fire department codes. Additionally, the solar map contains an incentive calculator that allows users to estimate the environmental and financial benefits of a solar energy system based upon assumptions related to usable roof area, incentives, and system costs that are clearly detailed on the map as well as user inputs that help produce customized results. The solar map also produces additional data not visible to the public for use and consideration by city staff and elected officials, including the number of visits to the solar map each day and which locations generate those visits, and it charts the number of solar installations installed in the city.

The solar map also allows users to determine if their property

PV systems installed on 15 municipal buildings. As of August 2012, these facilities were producing 2.3 MW of electricity annually, halfway to the city's goal.

The City of Boston is using its solar map to assist in tracking the city's progress toward meeting its clean-energy goal of reducing greenhouse gas emissions by 25 percent by 2020. The progress tool indicates that the city is currently producing 7.8 MW of solar power compared to its goal of 25 MW by 2015.

The City of Denver is using its solar map to monitor success in educating the public about solar information. In the map's first month of activity it saw nearly 8,000 unique visitors, and within the first two months of the map's release, 14 leads had been generated for solar installers from an online form (NARC 2012). Staff also plan to use the data for additional measurement purposes, including the number of jobs created.

Opportunities for Improvement

Solar maps serve as valuable tools to a variety of users. They provide quick and easy initial assessments of a property's solar potential and serve as excellent educational resources for the community. There are some variables not commonly incorporated into solar maps, however, about which users should be aware. The first is shading from trees and vegetation. Unless the map offers a shading slide tool (as in Portland's case), most solar

is in one of five Solar Empowerment Zones identified by the NYC Solar America City Partnership, areas in which solar energy installations will provide the greatest benefits to New Yorkers and the electric distribution system. Property owners in these zones may be entitled to benefits such as free data acquisition systems, technical assistance, and additional incentives. The Solar Empowerment Zones and the NYC Solar Map also assist ConEdison in determining where solar can best contribute to energy production, which could potentially defer or eliminate the need for costly upgrades to the electrical system that would increase electricity rates. ConEdison uses the solar map to evaluate the impact of solar production on network reliability, integrate solar into smart grid efforts, and improve demand-side management applications.

Sustainable CUNY's current DOE grant is helping to fund additional solar initiatives which will enhance the solar map's capabilities. Currently the solar map tracks solar capacity, but limited ability exists to track real-time solar energy generation of each installation. CUNY Ventures, a CUNY Economic Development Corporation entity, has partnered with IBM to create an Intelligent Operations Center (IOC) for solar that can link to the map. Once completed, the IOC will be able to display real-time energy generation outputs as well as other analytics. The Mayor's office will be able to use this data to measure progress against established energy goals. City and state energy policy holders will be able to analyze the actual value of PV generation to grid-constrained areas, which is a crucial tool for designing solar policies and programs that can help the city meet requirements to generate 80 percent of its peak electrical load within city limits.

Other planned map enhancements include adding solar thermal components, strengthening the functionality of the map and improving its interactive nature, increasing the level of detail available with the drawing tool, and adding additional override flexibility so that a user can insert property-specific details when available into the map instead of relying on pre-populated inputs. Discussions are also underway to expand the map across the state of New York, though this requires obtaining LiDAR data for remaining communities which is critical to ensuring the same map precision afforded in New York City. Finally, Sustainable CUNY believes that the NYC Solar Map may be expanded to include other renewable energy sources, transforming the NYC Solar Map to the NYC Energy Map.

Since 2006 New York City has experienced a 1000 percent increase of solar energy capacity. Earlier this year, the city surpassed its 2015 solar energy target of 8.1 MW—three years early. As of June 2012, the city's solar capacity is 11.5 MW. The number of solar installations in the city exceeds 560 and the number of NYC solar installation companies has quadrupled.

The NYC Solar Map has played an integral role in advancing solar initiatives in NYC. The information generated by the map has helped a variety of stakeholders including the general public, utilities, planners, and elected officials understand the benefits of solar energy, and the planned map enhancements will only further increase the use of solar energy in the city.

The Solar Map is available on the Sustainable CUNY web site at http://nycsolarmap.com/.

maps consider shade from neighboring buildings but not from trees and vegetation. See the fifth briefing paper in this series, "Balancing Solar Energy Use with Potential Competing Interests," to understand why this could lead to potential future conflicts.

Second, most solar maps do not take into account existing regulations such as dimensional or development standards like height or placement requirements outlined in the zoning ordinance. Additionally, the maps do not factor in redevelopment potential in built-out areas. For example, surrounding buildings may be built to heights lower than the maximum height allowed. Redeveloping buildings to maximum height could impact a system's effectiveness.

Additionally, few smaller communities have taken an interest in solar mapping. This could be due to a variety of factors including lack of interest or knowledge, lack of adequate data, concerns over privacy, development costs, or staff qualifications. Although urban centers have a high number of rooftops, these spaces commonly house a variety of other objects including HVAC systems, skylights, greenroofs, or outdoor spaces which can reduce their solar energy potential. Although smaller communities may have less rooftop square footage, this square footage may be better suited for solar installations. This solar potential has not been adequately explored (Leitelt 2010).

Conclusion

Solar maps are innovative tools communities can use to promote greater public awareness about solar potential and to facilitate greater solar usage among property owners. They are user-friendly and interactive, generate immediate results, and can provide a complete resource for information on solar. Although solar maps are a relatively new tool, communities are beginning to realize the important roles they can play in achieving sustainability goals. Solar maps can be used to consider potential outcomes of various future solar scenarios as well as measure successes against established solar goals. They can help diminish individual uncertainty surrounding solar power by providing quantifiable data on installation costs, cost savings, energy savings, and local, state, and federal resources. In the future, solar maps will play pivotal roles in helping individuals and communities recognize their solar potential and the financial and environmental benefits associated with capturing that potential.

This solar briefing paper was written by Erin Musiol, AICP, Senior Program Development and Research Associate at the American Planning Association, with Steph Stoppenhagen, Client Service Manager for Sustainability at CH2M HILL. Case study information provided by Laurie Reilly, Sustainable CUNY Communications, and Brad Stratton, New York City Solar Ombudsman.

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Cover: San Francisco's solar map provides solar facts about the city including the number of PV systems installed, total CEC-AC capacity, estimated energy produced, estimated annual savings, and annual CO_2 reduction. *(Image courtesy: http://sfenergymap.org/)*

Integrating Solar Energy into Local Plans

Communities adopt local plans in order to chart courses for more sustainable and livable futures. Planners and public officials then use these plans to inform decisions that affect the social, economic, and physical growth and change of their communities. Given the potential economic and environmental benefits of local solar energy production, it is no wonder that an increasing number of cities and counties are addressing solar energy in their plans.

Local solar market expansion means lower monthly energy bills for homes and businesses with solar installations and new jobs for solar installers. Furthermore, increasing local solar energy production reduces the demand for fossil fuels and, by extension, the production of greenhouse gas emissions. Regardless of the specific justifications for prioritizing solar energy use on local agendas, the simplest reason for addressing solar energy in local plans is to provide residents and potential solar developers with a clear vision of community priorities as they relate to solar energy production.

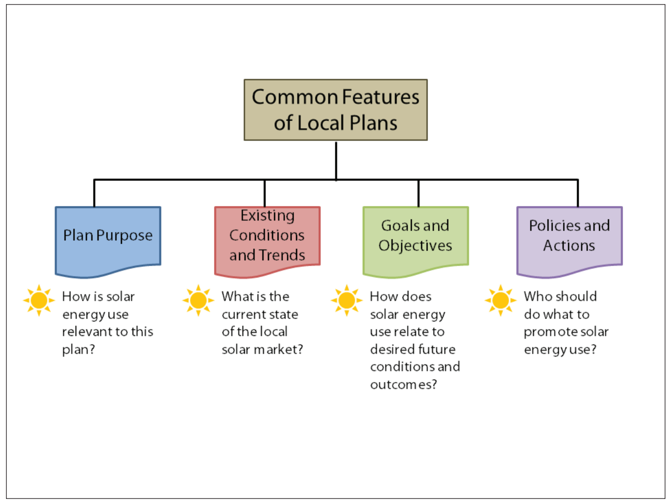
Most local plans fall into one of three broad categories: (1) comprehensive plans, (2) subarea plans, or (3) functional plans. In this conceptualization, comprehensive plans cover a wide range of topics of communitywide importance. In contrast, subarea plans cover one or more topics of particular importance to a limited part of a single jurisdiction, and functional plans focus on a single topic or system that is not limited to a single subarea. While some communities have adopted functional plans on the specific topic of solar energy use, many others address solar energy in comprehensive or subarea plans or in functional plans covering climate change, sustainability, or energy.

There are a number of possible references to solar that may appear in any policy-oriented plan. For example, a broad vision statement may relate how solar energy production intersects with general community values. An introductory background section may describe the existing physical and policy conditions for producing solar energy, and subsequent chapters or elements may state specific goals, objectives, policies, and actions relevant to promoting solar energy production. The substance of these references to solar will, naturally, vary depending on community preferences as well as the type of plan.

The purpose of this paper is to provide planners, public officials, and engaged citizens with an overview of established and emerging approaches to integrating references to solar energy into local plans. The initial sections focus on addressing solar energy use in features common to many types of plans, and the paper concludes with issues specific to comprehensive, subarea, and functional plans.

Addressing Solar Energy Use in Common Plan Features

While local plans vary based on geographic scale, timeframe, and breadth of topics, there are four features common to most local plans: (1) an explanation of the purpose of the plan, (2) a discussion of existing conditions and trends, (3) a presentation of desired outcomes in the form of goals and objectives, and (4) an enumeration of policies and actions in support of these goals and objectives. Planners and others involved in plan making (i.e., plan authors) have opportunities to address solar energy use in each of these common plan sections.



Plan Purpose

The purpose section allows plan authors to explain the plan's impetus, scope, and authority, while also providing some insight into the nature of the planning process. In practice, the plan purpose may be articulated in one or more introductory paragraphs, or it may be stated broadly up front and then revisited or reframed in the introduction to each thematic plan element.

Regardless of the form of the statement in a particular plan, a core purpose of local planning is facilitating the development or protection of community resources. Because sunlight can be harvested for heat or electricity, it has a value beyond its intrinsic human health benefits. However, relatively few communities acknowledge solar energy as a resource comparable to other local resources such as vegetation, water, minerals, fossil fuel reserves, or historical buildings and heritage sites.

Unless the scope of the plan is limited to identifying opportunities to promote solar energy use, a plan purpose statement may not explicitly reference solar energy. However, one way to help community members start to see solar energy as a local resource is by simply pointing out the nonlocal and nonrenewable origins of most locally used energy. For example, the Solar Access Protection element of Shakopee, Minnesota's 2030 Comprehensive Plan begins with a warning that the State of Minnesota currently produces only 0.2 percent of the fuel it uses.

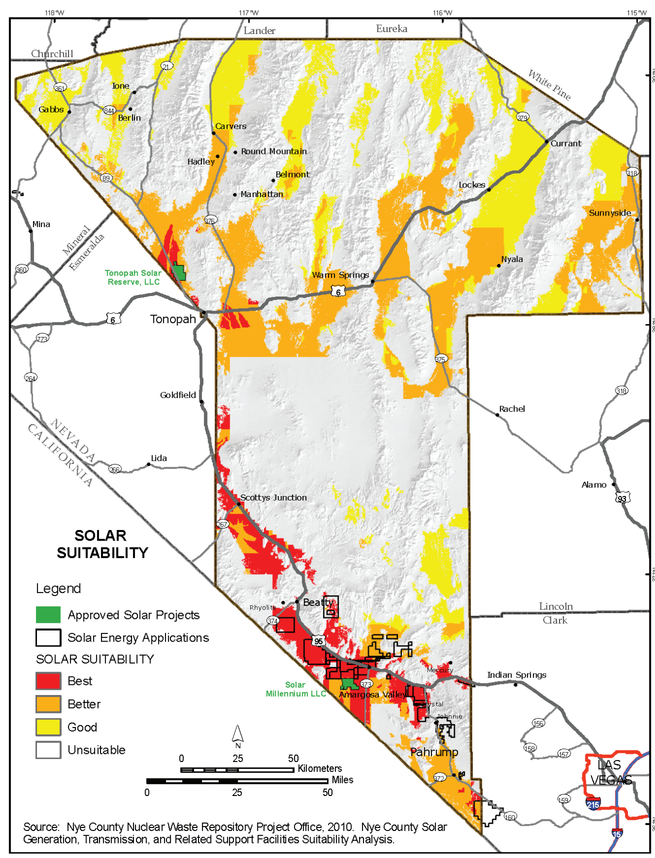
Existing Conditions and Trends

The existing conditions and trends section provides context for the broad goals and objectives of the plan and sets the stage for the policies or policy considerations detailed in subsequent plan sections. Understanding the potential importance of a community's solar resource requires some knowledge of both the availability of the local solar resource and the community's existing energy use. Plan authors can use this section to document the amount of energy consumed, the mix of energy sources currently used in the community, information about existing installed solar capacity, and a summary of how local solar investment has changed over time.

While a national map of the photovoltaic solar resource of the U.S. will show that solar energy production is a viable option across the country, demonstrating how access to sunlight may vary across a community can be especially helpful. The potential for harvesting this resource in a specific location depends primarily on local landscape variables rather than general conditions such as latitude and average cloud cover. Topography and shading from trees and adjacent buildings has a greater impact on the available solar resource for a specific building or site than whether or not the property is located in Arizona, Minnesota, or North Carolina.

Identifying where solar energy potential is greatest in a community can help residents, business owners, and developers understand how to direct their efforts and investments, and from a broader perspective, this information helps elected officials make decisions about where to focus future development and conservation efforts. The second briefing paper in this series, "Solar Mapping," explains how several communities have created solar maps to demonstrate the potential for solar installations across their jurisdictions.

Once a community has documented the geographic characteristics of its solar potential, plan authors can summarize this information for community members. For



Nye County, Nevada's latest comprehensive plan shows the relative suitability of different areas of the county for solar installations. (Image courtesy of Nye County, Nevada)

example, the latest version of Los Angeles County's Conservation and Natural Resources General Plan Element includes a direct link to the county's online Solar Map and Green Planning Tool, and Nye County, Nevada, includes maps indicating solar suitability and documenting existing solar installations as figures in the conservation chapter of its 2011 Comprehensive Master Plan.

The existing conditions and trends section can also describe how technological and economic factors influence the local solar market. For instance, solar energy systems may be active or passive and may be used to generate heat or electricity, and these different solar technologies are associated with different costs and performance characteristics. Furthermore, the feasibility of different types of solar energy systems is influenced by state and local policies and incentives.

While an inventory of state and local policy incentives for solar energy use may be too detailed for an existing-conditions analysis in a comprehensive or subarea plan dealing with multiple topics, a functional plan focused exclusively on energy may include a summary of the state and local laws that encourage or inhibit solar energy use.

Beyond the state and local policy context, financial incentives can also exert a powerful influence on the local solar energy market. Unlike regulations, which tend to be relatively static, incentives are often more ephemeral. Consequently, instead of cataloguing existing state and local incentives for solar installations, it may make more sense for plan authors to describe the different species of incentives that have historically influenced local solar markets. For example, some common types of financial incentives for solar installations are renewable energy credits, tax credits, and equipment rebates. Plan authors can then provide a reference to an up-to-date resource, such as the Database of State Incentives for Renewable Energy (DSIRE), with more information about active programs and offers.

Perhaps the most easily overlooked factor influencing the local solar market is the knowledge and experience of local solar installers. Like incentives, local installer capacity is dynamic and can change rapidly as new installers enter the marketplace or existing installers acquire additional experience or training. While plan authors may not be able to discuss local capacity in detail, they can help community members understand how limited installer knowledge and experience may present a barrier to expanding the local solar market.

One example of a community that has included extensive information about baseline conditions and trends related to solar energy is Tucson, Arizona. The city's Solar Integration Plan and its companion, the Greater Tucson Solar Development Plan: Strategies for Sustainable Solar Power Development in the Tucson Region, provide a thorough analysis of existing solar capacity and the factors likely to influence market growth.

Goals and Objectives

Almost all local plans contain one or more sections presenting goals and objectives related to the plan's focus. Goals are general statements about desirable future conditions. Objectives are statements of measurable outcomes in furtherance of a certain goal. Together, goals and objectives comprise the cornerstones of a local policy framework. In other words, all local policies and implementation actions should ideally be in furtherance of adopted goals and objectives.

Most communities formulate and prioritize goals through participatory planning processes. These processes may include formal visioning and goal-setting exercises as well as various other citizen engagement tools used by planners to facilitate conversations about the future of their communities. The first briefing paper in this series, "Solar Community Engagement Strategies for Planners," describes the importance of engaging the community to develop goals related to solar energy.

Each goal in a plan may be associated with multiple objectives. Again, these objectives are ideally byproducts of robust and authentic participatory planning. Effective objectives are both achievable and subject to measurement. In order to formulate an achievable objective, participants in the planning process must have access to the best available data and analysis on the issue at hand. Moreover, objectives should, ideally, be associated with a timeframe. This may be the time horizon of the overall plan, or it may be specific to the objective.

The process of formulating goals and objectives may be the first and best opportunity for planners and other participants to work through potential conflicts among goals. The fifth briefing paper in this series, "Balancing Solar Energy Use with Potential Competing Interests," highlights some potential conflicts among goals that may affect efforts to promote solar energy.

Among communities that have added goals and objectives related to renewable energy, generally, or solar energy, specifically, to their plans, common themes include improving the energy performance of municipal facilities, removing barriers and creating incentives for small-scale installations, and capturing economic development opportunities associated with renewable energy investment. As an example, Pinal County, Arizona, lists the following goals and objectives in the Environmental Stewardship chapter of its latest comprehensive plan:

- Improve the energy efficiency of Pinal County government (Goal 7.3).
- Set an example by improving energy efficiency and use of renewable sources in County facilities, vehicle fleets, and equipment (Objective 7.3.1).
- Expand renewable energy in Pinal County (Goal 7.6).
- Support small scale renewable energy projects (Objective 7.6.1).
- Support the growth of renewable energy in Pinal County (Objective 7.6.2).

Policies and Actions

Effective local plans typically include both specific policy statements and action steps. Policies are statements of intent with enough clarity to guide decision making, and actions are directives about programs, regulations, operational procedures, or public investments intended to guide the implementation of specific policies.

While goals and objectives generally remain abstract, policies point to a course of action and imply responsibility for implementation. To illustrate, a goal to expand local renewable energy production, with an objective of increasing solar energy capacity to a certain level by a target date, says little about what roles local government, private developers, and individual property owners should play in order to meet this goal. However, a policy stating that rooftop residential solar installations should be permitted in all areas of the jurisdiction implies that the local legislative body will adopt new zoning regulations for accessory solar energy systems.

Action steps make the implied responsibilities of policy statements explicit. For example, a plan with a policy sanctioning residential solar installations may include a directive for the planning staff to prepare a zoning amendment for city council review that defines accessory solar energy systems and permits these systems by right in all districts.

Among communities that have added policies and actions related to solar energy to their plans, common topics include adding solar to municipal facilities, solar access protection, regulatory or financial incentives for small-scale solar installations, and preferential locations for new solar energy systems. Fort Collins, Colorado, and Chico, California, provide two examples of communities that make clear connections among solar-related goals, policies, and actions in their most recent comprehensive plans. Both plans include multiple policies aimed at expanding active and passive solar energy systems on public and private property, and both plans detail specific actions and identify parties responsible for implementing these policies.

Addressing Solar Energy Use in the Comprehensive Plan

While planners help towns, cities, and counties prepare a wide range of communitywide, subarea, and functional plans, the most significant of these is the local comprehensive plan. The comprehensive plan, sometimes referred to as the general plan or the master plan, is the foundational policy document for local governments. In many ways it functions like a community constitution, establishing a framework for future growth and change within the jurisdiction to be implemented through local laws and public investments over the next 20–25 years.

Comprehensive plans are named as such because they cover a broad range of topics of communitywide concern. All states either allow or require local governments to prepare comprehensive plans, and many states require local development regulations to be in conformance with an adopted comprehensive plan. While enabling laws vary from state to state, common topics for plan elements (i.e., chapters or major sections) include land use, transportation, housing, economic development, and community facilities. In recent years an increasing number of cities and counties have added elements addressing sustainability, natural resources, or energy to their comprehensive plans.

Given the importance of the comprehensive plan in the local planning system, it represents a logical point to introduce solar energy–related goals and objectives in the context of the wider local policy framework. This gives plan authors a chance to highlight synergies and potential conflicts between solar and other community resources and to summarize any previous, ongoing, and planned policies and actions to support the implementation of goals related to promoting solar energy use.

The comprehensive plan is the legal foundation that legitimizes local land-use regulations. As such, it is important for plan authors to establish a policy foundation in the comprehensive plan for development regulations that affect solar energy use. The fourth briefing paper in this series, "Integrating Solar Energy into Local Development Regulations," discusses the importance of clear zoning and subdivision standards in removing barriers to and incentivizing the installation of solar energy systems on private property.

Ideally, the local comprehensive plan is a primary guide not only for updates to development regulations but also for the creation of local capital improvements plans, which detail planned capital expenditures over a multiyear period. By extension, comprehensive plans with goals, objectives, policies, and actions that support solar energy use can pave the way for future public facility construction or rehabilitation and private development projects that incorporate solar energy systems.

In the most recent versions of their comprehensive plans, Orlando, Florida, and Anaheim, California, both tie previous and ongoing activities that support solar energy use to new policies that support local solar market growth. Orlando's plan voices support for ongoing partnerships with the local utility commission and county government to support renewable energy initiatives and includes policies calling for the creation of a solar mapping tool and a solar master plan. Meanwhile, Anaheim's plan references an existing city-owned solar installation and discusses ongoing public education efforts before listing policies that clarify the city's intent to support active and passive solar design in both new and existing development.

Addressing Solar Energy Use in Subarea Plans

Subarea plans are plans that include goals and objectives for a discrete geographic area within a jurisdiction. Some common types of subarea plans include plans for specific sectors, neighborhoods, corridors, or special districts, such as transit station areas, redevelopment areas, or areas designated for historic preservation. These plans may cover a wide range of topics relevant to the plan area, essentially functioning as smaller-scale comprehensive plans, or they may be strategic in nature, focusing on a subset of topics with special urgency.

The limited extent of subarea plans has both advantages and disadvantages. Because comprehensive plans can seem abstract or diffuse to residents, business owners, or institutions that identify more with specific neighborhoods than with the city as a whole, planners often have an easier time identifying and engaging key stakeholders when a plan has clear implications for these stakeholders' homes, businesses, and shared public spaces. The other clear potential advantage of subarea plans is that these plans can be more specific about how goals and objectives apply to individual parcels of land. On the flip side, strong emotions can lead to a loss of objectivity, making it difficult for communities to prioritize scarce resources.

When considering the limited extent and greater specificity of subarea plans in the context of planning for solar energy, plan authors have opportunities to discuss the neighborhood- or parcel-level implications of policies and actions aimed at increasing adoption of solar technologies. Subarea plans can provide greater detail about preferred locations for solar installations and go into more depth about the regulations, incentives, and potential competing interests that may either support or inhibit local solar market growth.

Many communities incorporate design guidelines for future development into subarea plans. For example, both Austin,

Lawrence Township, New Jersey, Green Buildings and Environmental Sustainability Element of the Master Plan Goals, Objectives & Strategies: Energy Conservation and Renewable Energy Production			
Goal B:	**Promote local production of renewable energy.**		
Objectives		**Strategies**	
#1.	Revise the Land Use Ordinance to make it easy for property owners in all zone districts to produce renewable energy on their property as accessory uses.	(a)	Accessory solar/photovoltaic shall not be subject to particular design standards intended to screen them from public view.
		(b)	Within historic districts, solar/photovoltaic shall be permitted; however, their placement and design should be compatible with the historic character of the building/district or screened to the extent practical. Specifically, renewable energy structures, such as solar panels, should be placed such that they are not visible on the front of an historic building or a building located in a historic district.
		(c)	Encourage property owners to cover roof tops and surface parking lots with solar/photovoltaic structures.
		(d)	Creation of solar power facilities on undeveloped land is strongly discouraged because of potential loss of carbon sequestration, natural eco-systems and habitats, and potential stormwater impact from ground mounted systems. However, an exception is the installation of renewable energy facilities on agricultural lands and managed open spaces, such as meadows, in such a way that the agriculture or managed open space use may be conducted and is viable under the renewable energy facility.
		(e)	The Township should encourage property owners who have existing solar facilities or are proposing to install them to enter into solar easements with neighboring property owners in order to ensure continuing access to sunlight for a solar facility.
#2.	As upgrades and renovations become necessary, municipal facilities and infrastructure should incorporate renewable energy production.	(a)	The Township should consider incorporating new renewable energy production, such as solar power, into existing and any future facilities.
		(b)	The Township should consider infrastructure upgrades and changes to facility operations that utilize renewable energy. Infrastructure upgrade examples include but are not limited to solar powered streetlights. Changes to facility operations include but are not limited to installation of energy efficient lighting.

Texas, and Amherst, Massachusetts, have adopted neighborhood plans that address solar design. Austin's Brentwood/Highland Combined Neighborhood Plan recommends subdivision layouts and lot configurations that maximize solar access, and it encourages concentrating windows on the south face of buildings to promote passive solar heating. Similarly, Amherst's Atkins Corner plan includes a workbook of sustainable development design options, which highlights the importance of solar design as part of an overall strategy to maximize climate-friendly development.

Addressing Solar Energy Use in Functional Plans

Functional plans are stand-alone plans for systems or special topics that have spatial planning implications but are not, fundamentally, rooted in a single subarea of a community. Examples include capital improvement plans, affordable housing plans, transportation system plans, and open space network plans. And as an increasing number of communities acknowledge the importance of energy and climate planning, other functional plans—such as sustainability plans, climate action plans, and energy plans—have become increasingly common.

Some communities use functional planning processes as a way to incrementally create or update comprehensive plans. Alternately, other communities create functional plans either to address new topics rising on the public agenda or in response to special federal or state funding requirements. One topic that may be worthy of additional planning consideration is the role that solar energy use plays in vacant land management. The sixth briefing paper in this series, "Recycling Land for Solar Energy Development," highlights some key issues related to planning for solar on vacant properties.

While there are numerous local sustainability, climate action, and energy plans that incorporate goals, policies, and actions related to promoting solar energy, these plans seldom hold the same statutory authority as the comprehensive plan. Therefore, communities should incorporate relevant solar policies and action items from these functional plans into the comprehensive plan. This may involve incorporating functional plans into the comprehensive plan by reference, or it may mean updating specific sections of the comprehensive plan to reflect new community priorities.

As an example, in 2010 Lawrence Township, New Jersey, adopted a Green Buildings and Environmental Sustainability plan as an update to the township's 1995 Master Plan. The new plan element contains an explicit reference to New Jersey's planning enabling law, discusses existing conditions relating to solar energy production, and lays out several specific goals, objectives, and policies for promoting solar design and installations in both private development projects and municipal facilities.

Conclusions

Planners have a variety of opportunities for incorporating goals, objectives, policies, and actions that support solar energy use into local plans. And there are a number of justifications for doing so. While the simplest justification may be to provide residents and potential solar developers with a clear vision of community priorities as they relate to solar energy production, it is also important to lay a legally defensible groundwork for any regulatory changes that communities undertake to encourage solar installations. Furthermore, local plans provide a basis for public officials to address potentially competing goals, such as conflicts between protecting solar resources and preserving historic structures or existing trees.

A simplistic view of local planning inevitably emphasizes the idea of linear planning processes, where communities prepare and adopt a comprehensive plan and then subsequently prepare and adopt subarea plans, capital improvement plans, and development regulations, which then function as implementation measures for the comprehensive plan. However, in practice, planning is iterative, and new community goals and priorities may be as likely to emerge through a functional planning process as through a traditional comprehensive planning process. The truth is that communities create plans at different times and for different reasons (e.g., vocal stakeholders or special funding opportunities). Because not all plans carry the same weight in the eyes of courts, it is important to ensure consistency with the comprehensive plan throughout the entire local planning system.

This briefing paper was written by David Morley, AICP, APA's Planning Advisory Service Coordinator, with assistance from Brian Ross of CR Planning and Darcie White, AICP, of Clarion Associates.

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Integrating Solar Energy into Local Development Regulations

Many communities recognize the economic and environmental benefits of local renewable energy, generally, and solar energy, specifically. Homes and businesses with solar installations will have lower energy bills, and new solar energy systems mean new jobs for local installers. Also, by increasing their use of solar energy, communities can decrease air pollution, greenhouse gas emissions, and the secondary impacts that mining or drilling for fossil fuels have on the environment and surrounding communities.

One of the keys to local solar market growth is a supportive regulatory environment. Planners write, amend, and administer standards, policies, and incentives that have important influences on the nature and timing of future private development as well as what, where, and how local resources are used or protected. Applying this idea to the solar resource, planners can examine zoning codes, building codes, subdivision codes, and other regulations and ordinances to determine if—and how—they address solar energy, and whether barriers, either intentional or unintentional, exist. Where codes are silent on the subject, they can propose amendments to enable communities to take advantage of this clean, local energy source, and suggest incentives to encourage solar energy use.

This briefing paper provides planners, public officials, and engaged citizens with an overview of three aspects of integrating solar energy into local development regulations—removing barriers, creating incentives, and enacting standards—and offers examples from communities across the country that are taking steps to support local solar market growth.

Preparing for Regulatory Change

Before initiating regulatory reform, planners have a responsibility to help communities clarify how their goals and priorities relate to solar energy use. In practice this often means formally introducing solar energy into the community conversation and educating residents and business owners about the local solar market. See the first briefing paper in this series, "Solar Community Engagement Strategies for Planners," for more information on responding to common questions and concerns about solar and using public engagement techniques to broaden the conversation. It is also important that planners help incorporate solar energy into the community's guiding document, its comprehensive plan. The third briefing paper in this series, "Integrating Solar Energy into Local Plans," explains how weaving goals, objectives, policies, and actions that support solar energy use into the local comprehensive plan makes these connections official and sets the foundation for taking action and realizing renewable energy goals.

Removing Barriers

Regulatory barriers to solar energy development can take a number of forms. Some barriers are obvious: homeowners' association covenants or design review requirements that prohibit or restrict solar panel installation, or zoning ordinances that restrict the types of districts in which solar facilities are allowed. Other barriers are more subtle, such as height restrictions, lot coverage limitations, or setback requirements that do not allow for the placement of solar panels on existing rooftops or building sites. Screening requirements for rooftop equipment and landscaping requirements that limit access to solar resources can also act as barriers, as can silence on solar energy systems in permitted use listings or design standards.

Though private homeowners' association covenants and restrictions are typically outside the control of local government, more than half of all states have passed solar rights laws that either limit the restrictions that private covenants can place on solar energy system installation or explicitly enable local governments to adopt regulations aimed at protecting solar access (DSIRE 2012a). Planners in these states can raise awareness around this issue and ensure that residents and local officials understand when private restrictions on solar energy systems will be preempted by state or local protections. In states without such protections, planners can encourage home-rule municipalities to adopt local provisions limiting private restrictions on solar energy system installation. The Model Solar Energy Standards provided by the Minnesota Environmental Quality Board offers the following sample language: "Restrictions on Solar Energy Systems Limited: No homeowners' agreement, covenant, common interest community, or other contract between multiple property owners within a subdivision of [Community] shall restrict or limit solar energy systems to a greater extent than [Community's] solar energy standards" (Part VI; MEQB 2012).

Planners can also introduce ordinance provisions that make solar a by-right accessory use in all zoning districts; craft exceptions to allow solar in special districts, such as historic preservation districts; add solar panels to the list of rooftop appurtenances (air conditioning units, skylights, chimneys, etc.) exempted from height restrictions; and allow modest adjustments to regulations to allow applicants access to the solar resource on their properties.

Seattle provides an example of how a community might take a close look at the solar-friendliness of its regulations. As part of its Solar America City program, the city commissioned a gap analysis of its municipal code to determine how well it complied with identified best management practices for increasing solar energy use. The final report provided recommendations for improving permitting processes and policies affecting solar energy implementation.

It is also important to provide clear information regarding the permitting process and associated code requirements for solar. In Portland, Oregon, the Bureau of Development Services has created program guides for solar energy system installation on one- or two-family homes, as well as on commercial buildings (Portland 2010). The guides define solar energy systems; explain installation requirements, including applicable development and design review standards as well as structural and electrical specifications; describe permitting requirements and processes; and offer submittal checklists for users. In San Jose, California, staff created a solar PV system residential inspection checklist to make it easier for property owners and installers to understand and track solar permitting and installation requirements (San Jose 2011).

Creating Incentives

Communities can create incentives by streamlining the approval process, reducing permitting costs, and increasing flexibility on other standards in exchange for the incorporation of solar. Tucson, Arizona, has passed resolutions waiving permitting fees through FY 2013 for qualifying solar energy systems up to a maximum of $1,000 for a single installation or $5,000 for a larger project. In San Diego, developers can qualify for expedited permitting by either achieving LEED certification or using solar PV to generate a certain percentage of energy needs in their projects (DSIRE 2012b).

Many zoning codes already include lists of development amenities for which developers may obtain density or floor area ratio bonuses; planners should make sure that installation of solar energy systems in new development are added to those lists. According to the zoning code of Pullman, Washington, for example, developers may obtain up to five density bonus points for new planned residential developments by incorporating solar orientation or solar energy systems into 50 percent or more of proposed dwelling units (§17.107.040).

Solar requirements may also be incorporated into municipal green building programs and policies, which typically require that new or retrofit construction meets a certain level of energy efficiency and environmental sustainability. Encouraging the incorporation of solar energy into building design and operations can be an easy way to help developers and property owners meet these standards. Fremont, California, recently adopted a green building ordinance that requires new low-rise residential construction to either meet minimum California Green Building Code requirements or achieve 50 points on the Build It Green GreenPoint Rated checklist—and installing a solar hot water system and PV panels counts for 16 points on that checklist (§7-1920.A4.601).

Enacting Standards

Finally, planners can help communities enact standards related to solar. It is important that communities address solar in their land use and development codes to eliminate uncertainty around where solar energy systems may or may not be allowed, ensure that installations are placed in appropriate locations, and mitigate any potential negative impacts. Clear standards can also help communities avoid conflicts over competing values, such as tree cover or historic character of protected districts or structures. The fifth briefing paper in this series, "Balancing Solar Energy Use with Potential Competing Interests," offers more information on how communities are addressing these issues. Finally, standards can help set the stage for future implementation of solar by ensuring that new development is situated for maximum solar access and new structures are wired and plumbed for solar electric and hot water systems.

When it comes to enacting standards, some baseline considerations include clarifying what types of solar systems are allowed and where; mitigating potential nuisances associated with solar equipment, such as visual impacts or encroachment; and addressing solar access issues. Communities should attend to basic zoning issues such defining solar energy–related terms; determining whether solar energy systems will be allowed as primary or accessory uses in each zoning district; setting forth height, lot coverage, and setback requirements; and describing relevant development standards for solar energy systems such as screening and placement (on building or site). Communities may also tackle solar easement and access requirements; site planning guidelines for lot and building orientation that maximize solar access; and solar-ready development standards wherein buildings are constructed to allow for the future installation of solar energy systems. Planners should also consider the context, such as residential, nonresidential, new development, or infill or redevelopment, when establishing such standards, as solar objectives may conflict with other community objectives (i.e., higher-intensity development) in some locations.

While specific standards will vary from community to community based on the community's goals and local context, there are a number of common types of provisions related to different aspects of solar energy use.

Accessory Solar Energy Systems

Say "solar energy" and most people think of solar panels on a roof. Indeed, small-scale—or, more accurately, accessory—solar energy systems in the form of ground-mounted or rooftop solar installations alongside or on a primary structure are the most common and familiar manifestation of solar energy implementation. These systems can range from a few solar panels or a solar hot water system installed on a residential bungalow to a much larger PV installation on the rooftop of a big-box warehouse or municipal building. The impacts of these systems are typically minimal, and rooftops in particular provide a vast amount of potential space for installing solar and generating electricity with no additional land consumption or impervious surface increase. The main concerns regarding these systems tend to be aesthetic: how and where systems are placed on a property. The basic considerations for these facilities are to make sure they are permitted in appropriate locations throughout the community and to address specific requirements by location.

Communities may address accessory solar energy systems in their codes in a number of ways. Some line-list them as permitted uses in defined districts; others define solar energy systems through accessory use provisions as permitted by right in both residential and nonresidential districts, often subject to

Impacts of accessory solar energy systems are typically minimal. (Image courtesy of DOE/NREL) specific development standards. Still other communities adopt a stand-alone chapter or section of the zoning code addressing solar energy (and often other renewable energy sources such as wind), stating where it is permitted and laying out specific development standards. Related definitions may be listed in that section, but are typically added to the zoning code's definitions section. A separate section may be the most user-friendly option, as residents can find all the information on solar in one spot, though an integrated approach, especially if the entire code is being updated, may allow for a more streamlined document overall.

Specific development standards typically address placement. Some communities encourage rooftop over ground-mounted systems and many communities require rooftop panels to be located on side or rear roof slopes rather than street-facing roof slopes, when possible, for aesthetic reasons. Some ordinances limit the height that rooftop panels may extend above the roofline (often 2 or 3 feet), while others exempt solar panels altogether from district height restrictions, along with other typical rooftop structures such as chimneys, air conditioning units, or steeples. Many ordinances also address system appearance, requiring neutral paint colors and screening of nonpanel system components. For ground-mounted systems, communities often restrict location to side or rear yards and sometimes require screening from public rights-of-way. In all placement and screening considerations, however, the effects of requirements on the efficacy of the panels' operation must be considered, and most ordinances provide for some degree of flexibility to ensure that property owners can work within site and structural constraints to achieve reasonable solar collection.

While accessory solar facilities are typically installed to meet on-site power needs for buildings and other uses, there is no need to place limitations on the size or power production capacity of an accessory system—height and location restrictions will place reasonable constraints on the size or extent of panels and their placement. In most states, net-metering arrangements allow solar energy system owners to feed excess energy back into the grid, "turning the meter backwards" and earning credits for that electricity, which can serve as a further incentive for solar energy installation—not to mention a local, decentralized power generation source. Adding stipulations that accessory systems be limited in capacity to on-site power needs or implementing an arbitrary system size cap can only act as a barrier to solar implementation.

Finally, some communities require that solar systems remain well-maintained throughout their working life, and mandate the decommissioning of panels once they cease to function properly or if they are abandoned for a certain length of time. This ensures safety and prevents obsolete or damaged panels from becoming hazardous or aesthetically blighting.

Some examples of accessory solar energy system provisions include those of Bethany Beach, Delaware, which added a stand-alone chapter on solar energy systems to its Town Code in 2010 (Chap. 484). It begins with a section on legislative intent that references solar energy's role in mitigating the need for additional electrical generation and reducing atmospheric pollution and encourages the use of solar energy systems in the town. Subsequent provisions establish solar energy systems as permitted uses in all zoning districts and encourage panel placement on side and rear roof slopes of principal buildings. There are no limits to the number of panels that may be installed as part of the system, though the main purpose of the system must be to generate power for onsite use—commercial solar operations are prohibited within the town. Hermosa Beach, California, addresses solar energy systems in the yard, height, and area restrictions chapter of its zoning code (§17.46.220). It allows solar energy systems to exceed height limits to the minimum extent necessary for safe and efficient operation and provides flexibility in modifying other development standards that might reduce system performance. Minneapolis, Minnesota, permits building-mounted or freestanding (ground-mounted) solar energy systems in all zoning districts subject to height limits and required setbacks (§537.110). Solar energy systems that do not comply with those regulations may be allowed by conditional use permit.

Solar Energy Systems as Primary Uses

As interest in renewable energy increases and more states pass renewable energy portfolio standards that require a certain percentage of state energy use to come from renewable sources, large utility-scale "solar farms"—centralized facilities that comprise the primary or principal use on a site—are gaining in numbers. These typically large-scale systems can have very different impacts on land use than accessory systems and may give rise to public concerns over these impacts. Planners should make sure that their communities' land-use codes allow for these uses where appropriate and that any potential nuisances are mitigated.

Primary-use solar farms, often large in scale, should be regulated to mitigate potential impacts. (Image courtesy of DOE/NREL)

When solar energy systems constitute a primary land use, most or all of the electricity produced is consumed off site. A major difference between these solar farms and small-scale, accessory systems is the amount of land that they occupy. As noted, most accessory use systems are placed on rooftops or limited by lot coverage or setback requirements and therefore have little to no impact on land use or consumption. In contrast, primary-use systems are ground-mounted and can range in size from less than an acre in urban settings to hundreds of acres in remote locations. This can raise concerns regarding impervious surface coverage, tree and habitat loss, transmission infrastructure, and construction impacts. Solar farm proposals can become controversial, especially when greenfields or productive agricultural lands are proposed as sites. Indeed, Santa Clara County, California, specifically prohibits commercial solar energy conversion systems on land designated for large-scale agriculture by the general plan, and allows this use on only those medium-scale agricultural lands that are deemed to be of marginal quality for farming purposes (Ord. NS–1200.331). On the other hand, a primary-use "community solar garden," in which local residents can purchase shares to support renewable energy production as an alternative to installing their own individual systems, may be fairly small in size and a more appropriate fit within developed areas.

Planners should be aware that primary-use renewable energy facilities can be a great match for vacant industrial or brownfield sites. The site cleanup requirements for a solar farm are typically less extensive and costly than they would be for recreational, commercial, or residential uses, and a solar farm can be dismantled and moved to make way for a higher and better use of the property if other redevelopment opportunities eventually arise. See the sixth briefing paper in the series, "Recycling Land for Solar Energy Development," for guidance on taking advantage of these opportunities.

Because of the greater impacts that may be associated with primary-use solar energy systems, many communities restrict their locations to rural, industrial, agricultural, or certain commercial zoning districts. Solar farms may be allowed as by-right uses, but typically in very limited locations; more frequently they are designated as conditional or special uses. Common development standards include height limitations, setbacks from property lines or neighboring structures, and screening from adjacent public rights-of-way. For security and safety reasons, many communities require that solar farms be securely fenced, that warning signs be posted, and that on-site electrical interconnections and power lines be installed underground. Some communities establish a minimum lot size to better control where these facilities can be located within their jurisdictions.

Some communities also provide some guidance for the permitting process. Required documentation for a solar farm permit typically includes a detailed plot plan, as well as an agreement with a utility for interconnection of the completed facility. Some ordinances include stormwater management considerations, and in more rural communities or areas that abut public land environmental analysis for potential impacts on wildlife and vegetation may be required. Finally, decommissioning of facilities once they are no longer operational is typically required, with some communities requiring restoration of the site to its previous condition, especially for formerly agricultural lands.

Cities and counties throughout the country have adopted regulations for primary-use solar energy systems. For example, Erie, Pennsylvania, permits urban solar farms by right in certain industrial and manufacturing zones, and as a conditional use in others (Ord. 4-2010). Fencing, safety signage, and undergrounding of on-site power lines are required. Permit applications require a plot plan and utility notification, and solar farms inactive for one year must be removed and the site restored to its natural condition within six months of the removal. Granville County, North Carolina, permits ground-mounted solar energy systems as conditional or limited approval uses in industrial districts; other provisions establish height, setback, and screening requirements and require compliance with building and electrical codes (§32-233). Iron County, Utah, provides 13 considerations for conditional use review for solar power plants, including siting considerations, analysis of local economic benefits, visual impacts, environmental analysis, and transportation plans for construction and operation phases (Chap. 17-33).

Solar Access Ordinances

Allowing solar energy systems is key to encouraging local renewable energy production, but standards that define and protect the rights of property owners to sunlight are also important. Solar access ordinances guarantee property owners a reasonable amount of sunlight and protect installed systems from being shaded by structures and vegetation. There is currently no federal property "right" to sunlight for solar energy production. The only places where such a right exists is in states that have passed such statutes, and in places where local governments have created some sort of a "right" via ordinance. See the fifth briefing paper in this series, "Balancing Solar and Other Potential Competing Interests in Communities," for more information on how states and municipalities are addressing this issue.

Resources: Solar Energy in Development Codes

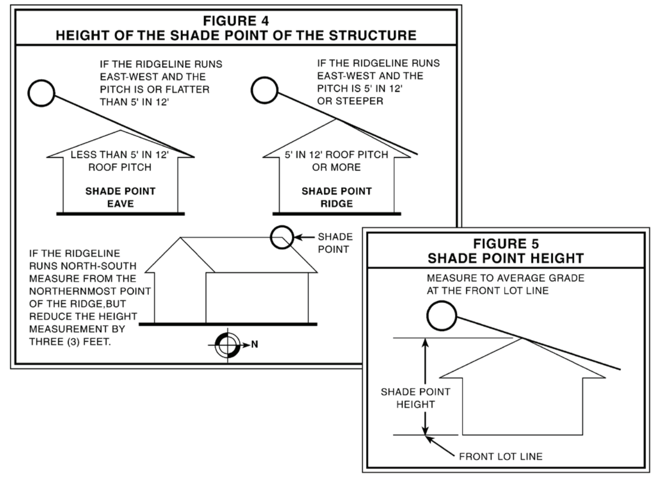
The following are some resources that provide guidance on integrating solar energy into land development regulations and processes:

- "Planning and Zoning for Solar Energy" (American Planning Association, PAS Essential Info Packet 30, 2010; www.planning.org/pas/infopackets/open/eip30.htm). This packet offers background articles and reports on planning and zoning for solar energy, as well as a collection of model and sample ordinances on a range of solar code elements.
- "SunShot Solar Outreach Partnership" (American Planning Association, 2012; www.planning.org/research/solar/). This site offers additional resources on planning and zoning for solar energy, including solar zoning FAQs, an annotated resource list, and links to webinars on solar energy implementation.
- "DSIRESolar" (Database of State Incentives for Renewables and Efficiency, U.S. DOE, 2012; www.dsireusa.org/solar). This comprehensive online searchable database lists federal, state, and local solar-related incentives, policies, and regulations by state.
- "Site Design Strategies for Solar Access" (Section 8.2, *Sustainable Community Development Code*, Rocky Mountain Land Use Institute, 2012; www.law.du.edu/index.php/rmlui/rmlui-practice/code-framework/model-code). This model code framework offers ideas and examples for removing barriers, creating incentives, and enacting standards for solar energy.
- "City of Seattle Code Review: Final Gap Analysis Report" (HDR Engineering, Inc., prepared for U.S. Department of Energy National Renewable Energy Laboratory and City of Seattle, 2010; http://www.seattle.gov/dpd/cms/groups/pan/@pan/@sustainablebldg/documents/web_informational/dpdp018774.pdf). This report describes an audit of Seattle's codes relative to solar energy development and lists best practices for a range of solar code elements.
- "Profiles in Regional Solar Planning: A Handbook and Resource Guide" (National Association of Regional Councils, 2012; http://narc.org/wp-content/uploads/DOE-Solar-Handbook.pdf). This guidebook offers case studies and tools for regional implementation of solar.
- "Solar Ready: An Overview of Implementation Practices" (NREL Technical Report TP-7A40-51296, 2012; www.nrel.gov/docs/fy12osti/51296.pdf). This report offers tools and suggestions for regulating solar-ready construction in communities.
- "Solar Powering Your Community: A Guide for Local Governments" (Second Edition, U.S. Department of Energy, Energy Efficiency and Renewable Energy, and Solar America Communities, 2011; www4.eere.energy.gov/solar/sunshot/resource_center/resources/solar_powering_your_community_guide_local_governments). This comprehensive guide to solar includes a chapter on updating and enforcing local solar rules and regulations.

Communities can provide for the protection of solar resources in three main ways: (1) solar easement, (2) solar access permit, and (3) solar "fences." In the first case, a property owner protects access to the sunlight needed by a solar energy system by negotiating solar easements with other neighboring owners and recording them with the appropriate authorities. Some states have enacted statutes defining and enabling local solar easements; one example is New Hampshire, which offers a model "Solar Skyspace Easement" template in its state statutes (§477:51).

In the second case, a property owner provides documentation of a solar energy system to the local government and obtains a permit providing protection from shading caused by future construction or tree growth on neighboring properties. To balance the rights of other property owners, communities may allow for some degree of system shading above a threshold that ensures the system's effectiveness will not drop below a certain percentage. For example, the Village of Prairie du Sac, Wisconsin, allows owners to obtain a solar access permit to protect their solar energy systems from "impermissible interference," including shading of more than 95 percent of collector surface between 9 AM and 3 PM each day (Chap. 8).

In the third case, a community establishes general solar protections for designated lots in the initial subdivision process—sometimes delineated by an imaginary "fence" creating a "box" on each lot within which sunlight must fall unobstructed by neighboring structures or vegetation, often for a certain daily amount of time (commonly defined as, at minimum, between two to three hours on either side of noon on the winter solstice). Neighboring property owners are prohibited from erecting any structures that would cast shadows during that time in the lot area protected by the ordinance. Boulder, Colorado, uses this approach to establish three different "solar access (SA) areas" that balance solar access with restrictions on development density and height (§9-9-17). The code provides for a "solar fence" in the first two SA areas that sets maximum allowable shading of a lot's building envelope; in the third SA area, solar protections are only granted for specific properties through permits. Solar access area designations may be amended by property owners through a public hearing and review process. Fort Collins, Colorado, limits the shading of structures on adjacent property to that generated by a 25-foot "hypothetical wall" located along the property line, but exempts certain high-density zoning districts from this provision (§3.2.3).



These figures from Clackamas County, Oregon, illustrate how solar access ordinances can provide detailed mechanisms for establishing and protecting access to sunlight for individual lots. (Image courtesy of Clackamas County, Oregon)

Solar Siting Ordinances

Besides allowing for the installation of solar energy systems within existing development, communities can also be proactive in designing and developing new subdivisions and structures to maximize their opportunities for using solar resources. Most existing development patterns and site layouts do not protect or take advantage of solar resources. A number of communities have added solar siting provisions to their subdivision codes or general site development standards to ensure that future development is optimally sited for solar use. These provisions sometimes go hand-in-hand with solar access requirements.

Solar siting ordinances set standards for lot size and orientation—as well as site layout for parcels—that provide for the construction of buildings whose southern sides or ends have unobstructed solar access for a designated time during each day (as in the case of solar access ordinances, typically a minimum of two to three hours on either side of noon on the winter solstice). Requirements include street and lot orientation within certain degrees of an east-west axis to ensure adequate sunlight access. Typically, a certain minimum percentage of lots within new subdivisions must then comply with these requirements. Solar siting ordinances may also place restrictions on the height and location of structures within the lot so that basic solar access to neighboring lots will not be blocked, or they may allow flexibility within setback regulations to maximize solar access for new construction. Such provisions do not only benefit homeowners who choose to purchase and install solar energy systems, but also maximize opportunities for the design of passive heating and cooling features.

To complement its solar access provisions, Boulder requires new residential development to have roof and exterior wall surfaces that are oriented toward the sun, have unimpeded solar access, and be structurally capable of supporting solar collectors. Similarly, Laramie, Wyoming, requires at least 40 percent of lots less than 15,000 square feet in area in single- and two-family residential developments to meet its "solar-oriented lot" definition, and development plans must protect access to sunshine for solar energy systems to the maximum amount feasible (§15.14.030.A.3). Dixon, California, includes solar orientation and incorporation of solar energy systems in its list of general site design standards for single-family homes (§12.19.21).

Solar-Ready Homes

Besides drafting amendments for zoning and subdivision codes to allow for the installation of solar energy systems and to protect access to sunlight for those systems, planners can also advocate for amendments to local building codes to promote and enhance solar implementation. "Solar-ready" home provisions require new construction to be electrically wired to support the later installation of solar PV systems and plumbed to support the later installation of solar hot water systems, and for roofs to be oriented, designed, and built to easily accommodate and support solar electric or hot water systems. Constructing the building to solar-ready standards is of little use, however, if the construction details are not available when the solar installation is ready to install a new system. Local governments have roles both in encouraging solar-ready construction and in holding solar-ready documentation in the building's permit history.

Some states, such as New Mexico, are adding solar-ready provisions to their energy codes. Local examples include Chula Vista, California, which has added photovoltaic pre-wiring requirements to its electrical code and solar water heater pre-plumbing requirements to its plumbing code that require all new residential units to include electrical conduit and plumbing specifically designed to allow the later installation of solar energy or hot water systems (§15.24.065; §15.28.015). In a different approach, Henderson, Nevada, offers solar readiness as one of a number of sustainable site and building design options developers can choose in order to earn "points" required for development approval (§19.7.12).

Model Ordinances

Though many communities already address solar in one form or another within their codes, other planners will be starting from scratch to incorporate solar provisions into their land development regulations. Luckily, planners do not have to reinvent the wheel on this topic; there is plenty of guidance and resource material available in the form of model ordinances, best practices, and sample regulations already adopted by other communities. Planners whose communities have already adopted solar provisions can also review model and sample ordinances to make sure their regulations are up-to-date and effective.

Model ordinances exist to help communities get started. Many include commentaries or different options to educate planners as to the most important aspects of solar regulations, as well as the reasoning behind various provisions. One example is the Minnesota Environmental Quality Board's model solar energy standards, which offers a general overview of solar energy issues and goals and provides model ordinance language and commentaries regarding rooftop and accessory structure solar installations (MEQB 2012). The model ordinance offers an extensive list of solar-related definitions and provides standards for solar energy systems as accessory uses permitted in all districts. It also addresses solar access through permitted solar easements and provides a list of incentives to promote development that integrates active solar energy systems. Another model ordinance, from the Center for Climate Change Law at Columbia Law School, focuses on small-scale solar energy systems, permitting rooftop, ground-mounted, and other systems by right in all districts subject to standards (Columbia Law School 2011). The model offers additional sections covering a fast-track solar permitting program and siting for future solar access.

Planners should remember, however, that models are just models, and as they draft new code provisions or amendments, they should be sure to tailor these regulations to local community contexts.

Conclusions

Solar energy use fosters economic activity and investment in a local resource and reduces air pollution, greenhouse gas emissions, and dependence on fossil-fuel energy sources. To help their communities better use this local energy resource, planners can highlight how local development regulations either support or inhibit the installation of both accessory and primary solar energy systems in different areas of their communities. After evaluating the effects of existing regulations, planners can then work to remove barriers, create incentives, and draft standards for solar energy use in existing and new development.

Fortunately, there are already a number of examples and models planners can look to for guidance as they seek to tailor a regulatory strategies for their communities. When consulting these existing resources, planners should adhere to three basic rules:

Use comparable examples: Identify peer communities with similar characteristics in terms of size, geography, climate, regulatory framework, development character, and natural and political environment, and review their codes as perhaps the most relevant.

Talk with the source: When possible, talk with the planners who wrote or who currently administer the ordinance. Ask them questions, such as how frequently the ordinance is being used, what's working and not working, and what they would do differently.

Do your homework: Be prepared to explain to your community members why specific aspects of your proposed regulations are necessary, and how they have been tailored to your community.

■ *This briefing paper was written by Ann Dillemuth, AICP, APA Research Associate, with assistance from Brian Ross of CR Planning and Darcie White, AICP, of Clarion Associates.*

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Balancing Solar Energy Use with Potential Competing Interests

Most communities pursue multiple goals simultaneously through a range of plans, policies, regulations, and programs. The decisions communities make in support of one goal may have a positive, negative, or negligible effect on other goals. When a community considers each goal in isolation, it may miss opportunities to address potential conflicts before they occur. Once a conflict exists, it may be too late to pursue a mutually beneficial solution, and communities may be forced to choose between competing interests.

As Godschalk and others have pointed out, sustainability goals are not immune to these potential conflicts of interest (Godschalk 2004; Campbell 1996). When the goal in question is promoting the installation of solar energy systems, historic preservation, tree protection, and even urban redevelopment may represent competing interests. Fortunately, planners' comprehensive approaches to problems and long-range perspectives make them uniquely positioned to address this dilemma. They consider potential tradeoffs and are charged with finding ways to balance different—and sometimes competing—community priorities and goals. Moving forward, planners can serve as key players in ensuring that these potentially competing interests successfully co-exist in the future.

Solar and Historic Preservation

Historic preservation and solar power generation are often both part of of a community's plan to become more sustainable. They have some notable similarities. Both are environmentally friendly. Historic properties were typically built with attention to climate and air circulation and with locally sourced materials, and they are usually located on walkable streets and in relatively central locations. Additionally, preservation of historic properties is "greener" than tearing down and rebuilding because of the energy and materials savings (WBDB 2012). Similarly, using renewable power from the sun in place of fossil fuels helps reduce carbon emissions that contribute to global warming.

Both have economic benefits as well. Designating a property or district as historic increases property values and attracts investment in and around the area. Homes with solar installations sell for more money while saving owners money on their energy bills (NTHP 2011).

However, while solar is part of an energy solution for the future, historic preservation is the key to protecting the community's past. Tension has developed between these two interests as communities struggle with how to both preserve their past and ensure a sustainable future.

The following discussion focuses on historic properties and historic districts, as planners have indicated that this is where they have experienced the highest potential for conflict. It should be acknowledged, however, that historic preservation is much broader than historic properties and historic districts alone. Communities should also consider potential conflicts between solar and other historic resources including public lands, cultural landscapes, tribal properties, historic landmarks, and archaeological sites during their planning processes.

The Dilemma

Historic preservationists and residents alike have strong desires to preserve the buildings and spaces that represent our nation's heritage and tell the stories of our past. Professional preservationists have ethical obligations to protect the integrity of these resources for future generations. Changes to a building's structure or façade to support a solar installation, as well as improper placement of an installation, can threaten the historic character and architectural integrity of historic resources. Unlike solar proponents, preservationists typically recommend that historic properties exhaust all possible weatherization options prior to the installation of a renewable energy system, including sealing windows and doors and installing insulation.

In addition to the intrinsic value associated with preserving our past, there are economic arguments for preserving historic properties and districts in their unaltered state. Historic districts often have significantly higher property values than comparable undesignated areas. They also help stabilize and revitalize declining neighborhoods (NTHP 2011). Neighboring property owners and other stakeholders may be concerned that architecturally insensitive changes associated with solar installations could reduce property values for nearby properties.

Proponents of solar, however, feel that solar technology can help strengthen the environmental profile of older buildings and help jurisdictions meet aggressive energy goals. Some proponents argue that renewable energy systems are necessary for older buildings to achieve the same level of energy efficiency as modern ones and that prohibiting homeowners from installing solar on their historic properties might doom those properties to replacement by new, greener structures (Musser 2010). How a community chooses to address this potential conflict can greatly impact its ability to maximize its solar potential or to protect its historic resources. Only a few states and local governments have addressed the issue head on.

Solar and State Historic Preservation Legislation

Many states have enacted solar rights legislation, which prohibits local governments from enacting restrictions that prohibit solar. Some states allow restrictions if they are "reasonable," which is defined differently from state to state (Kettles 2008). In most cases, historic buildings or districts are not explicitly addressed, which makes it unclear whether historic preservation is viewed as a reasonable restriction.

There are a handful of states, however, that have specifically addressed the issue. North Carolina makes its general prohibition on the adoption of laws restricting solar energy systems on residential properties applicable to historic districts but authorizes local jurisdictions to regulate the location or screening of solar collectors by "requiring the use of plantings or other measures to ensure that the use of solar collectors is not incongruous with the special character of the district" (N.C. Gen. Stat. §160A.400.4(d)). Even under the general prohibition, though, local governments may restrict solar energy systems to the extent that they are visible from the ground and installed on any facade or roof slope that faces common or public-access areas, or installed on a property within the area between the facade of a structure and common or public-access areas (§160A-201(c)). New Mexico prohibits a county or municipality from imposing restrictions on the installation of solar collectors except in a historic district (N.M. Stat. §3-18-32). And Connecticut prohibits a preservation commission from denying an application for a certificate of appropriateness for a renewable energy system unless "the commission finds that the feature cannot be installed without substantially impairing the historic character and appearance of the district." The commission may impose conditions on the issuance of a certificate of appropriateness, including design modifications and limitations on the location of the feature, provided that the effectiveness of the system is not significantly impaired (Conn. Gen. Stat. § 7-147f).

Local Actions Addressing Solar and Historic Preservation

Some municipalities have taken steps to explicitly address solar and historic preservation in their codes and ordinances. Howard County, Maryland (2009), and Alexandria, Virginia (1993), have adopted guidelines for solar panels in historic districts. Bayfield, Wisconsin, developed a document that details best practices in sustainability from a historic preservation perspective (NTHP 2012). In Texas, the City of Austin's zoning ordinance allows for a preservation plan in historic districts to incorporate sustainability measures such as solar technologies and other energy generation and efficiency mechanisms (§25-2-356, §25-2-531).

Two other communities, Montgomery County, Maryland,

and Portland, Oregon, have recently adopted guidelines and recommendations that address solar and historic preservation. Montgomery County amended its General Rehabilitation Design Guidelines in 2011 to specifically address solar panels. Portland revamped its zoning code to eliminate discretionary review of all new solar installations that comply with community design standards (Chap. 33.218). The community design standards make it easier for property owners to know what will be approved and what level of review a property owner can expect based on the location of the property.

However, these municipalities are the exception rather than the rule. Many jurisdictions fail to address solar in any capacity in their comprehensive plans or zoning ordinances, let alone specifically in their design guidelines for historic districts and properties. This ambiguity can create challenges on many levels. Residents are unclear about where they can install solar energy systems or whether these systems are even allowed, and persons serving on review boards and commissions may have trouble making consistent determinations. In some instances the uncertainty can discourage the installation of solar systems, which may work against solar energy goals. In other instances property owners may install systems without approval (knowingly or unknowingly) and officials can only react, issuing penalties and requiring "after the fact" applications for certificates of approval. If a community attempts to force a property owner to remove an installation, it opens itself up to a lawsuit if the property owner decides to appeal the decision or attempts to recoup installation costs.

Some communities may allow solar in historic districts or on historic properties, but their ordinances impose so many obstacles and restrictions on permit approvals that installing solar energy systems becomes unfeasible or impossible for applicants. Many times these restrictions were crafted to address other issues, such as alterations to historic roof lines or installation of satellite dishes, or are simply out of date. Some communities experiencing a sharp increase in the number of applications for solar systems have hastily developed historic preservation guidelines without identifying and engaging the appropriate stakeholders. Finally, some communities explicitly prohibit owners of historic properties from taking advantage of clear standards for the installation of solar energy systems in nonhistoric areas.

Solar installations on historic buildings and in historic districts are often considered on a case-by-case basis, leaving municipal review boards, commissions, and councils to resolve solar and historic preservation conflicts through their discretionary powers. Adding an additional level of ambiguity is the lack of any case law on the subject that could potentially provide local jurisdictions clear guidance on the subject matter.

A solar panel system was installed on the rear elevation of this historic property in the Heritage Hill Historic District of Grand Rapids, Michigan. By locating the system in the rear of the property, the views from the public right-of-way remain preserved. (Image courtesy of Kimberly Kooles, N.C. Solar Center.)

Can Solar Panels and Historic Preservation Get Along?

The variety of regulations, guidelines, and policies that have been developed pertaining to solar and historic preservation indicate that there is no uniform or concrete approach to determining whether a solar installation is appropriate on a historic resource. Most often disagreements arise not around the installation itself, but how the installation is done. Most agree that installation of solar panels is not acceptable when the installation involves removal of historic roofing materials, when the historic roof configuration has to be removed or altered to add solar panels, or when the installation procedure would cause irreversible changes to historic features. There are, however, multiple situations when installation of solar panels on a historic resource is generally viewed as acceptable. Panels are generally viewed as acceptable when they are

- installed on a building with a flat roof, at a low profile, and are not visible from the street;

Resources: Solar and Historic Preservation

Some widely agreed upon guidelines have been developed to illustrate when a solar installation may be appropriate and when it is not. These include

- "Illustrated Guidelines on Sustainability for Rehabilitating Historic Buildings" (U.S. Department of the Interior, National Park Service, Office of Technical Services, 2011; www.nps.gov/tps/standards/rehabilitation/sustainability-guidelines.pdf). These guidelines include a section dedicated to solar technology.
- "Design Guidelines for Solar Installations" (National Trust for Historic Preservation, n.d.; www.preservationnation.org/information-center/sustainable-communities/sustainability/solar-panels/design-guidelines-for-solar.html). This document provides a foundation for the adoption of local guidelines related to solar energy installations.
- "Sample Guidelines for Solar Panels in Locally Designated Historic Properties" (Kimberly Kooles, National Alliance of Preservation Commissions, 2009; www.preservationnation.org/information-center/sustainable-communities/sustainability/solar-panels/additional-resources/NAPC-Solar-Panel-Guidelines.pdf). This resource is intended to serve as a starting point for local preservation commissions developing their own guidelines for solar panels.
- "Implementing Solar PV Projects on Historic Buildings and in Historic Districts" (A. Kandt et al., National Renewable Energy Laboratory, 2011; www.nrel.gov/docs/fy11osti/51297.pdf). This technical report focuses on the implementation of photovoltaic (PV) systems on historic properties.
- "Developing Sustainability Design Guidelines for Historic Districts" (Nore Winter, National Trust for Historic Preservation, 2011). Communities can refer to these guidelines when developing or updating guidelines for solar installations in historic districts. Although this resource discusses sustainability guidelines in general, it does include specifics on renewable energy.

- installed on secondary facades and shielded from view from a primary façade (below and behind parapet walls and dormers or on rear-facing roofs);
- ground-mounted on nonhistorically significant landscapes and inconspicuously located on historic sites;
- located on new buildings on historic sites or new additions to historic buildings; or
- located complementary to the surrounding features of the historic resource (Kooles et al. 2012).

The following recommendations will assist planners in ensuring that solar and historic preservation can successfully coexist in their communities:

- Advocate for development of state solar-access laws (for states that do not have them) and changes to state solar-access laws (where they exist) to specifically address historic preservation.
- Identify historic preservation as a reasonable restriction in state solar-access laws and craft clear language that indicates when an installation is not acceptable.
- Revise, develop, and adopt local preservation guidelines or ordinances (tailored to the community) that address renewable energy and sustainable technology.
- Address historic preservation and solar jointly during the planning process. This includes discussing priorities during visioning and goal-setting exercises, addressing potential conflicts during the development of goals, policies, objectives, and action items, and identifying unintended barriers in existing guidelines and regulations.
- Perform an audit of the community's historic preservation guidelines and regulations to determine unnecessary or overly stringent barriers to solar installations.
- Ensure that the appropriate stakeholders, both historic preservationists and solar experts, are involved in the development of solar access guidelines and development regulations. Also ensure that they serve as members of local solar-advisory committees.
- Designate a board to make decisions regarding solar and historic structures. Ensure that the board has decision-making authority and representation from appropriate stakeholders.
- Design a review system and criteria to review and evaluate projects after installation on historic properties.

Consider updates to guidelines and ordinances when appropriate.

- Educate and increase citizen awareness of the benefits of both solar and historic preservation and best practices of sensible planning to avoid future conflicts.

Solar and Trees

Maintaining and enhancing the tree canopy is another common sustainability goal. Trees and solar energy systems also share similarities. Both require access to the sun, and both help reduce carbon emissions and curb pollution. When a tree's shade impacts the efficiency of a solar system, however, trees and solar become unlikely adversaries. The conflict has sparked debate about which is the higher local priority.

As states make commitments to promote alternative energy sources and reduce energy consumption, they have simultaneously made commitments to increase solar capacity. The California Solar Initiative (CSI), for example, has set a goal to reach 1,940 MW of installed solar capacity by the end of 2016 (California Public Utilities Commission 2012). These ambitious goals, coupled with the increasing affordability of solar energy systems and the adoption of financial incentives and financing programs, make an already contentious issue likely to become even more so as more people seek to install solar panels on their homes and businesses.

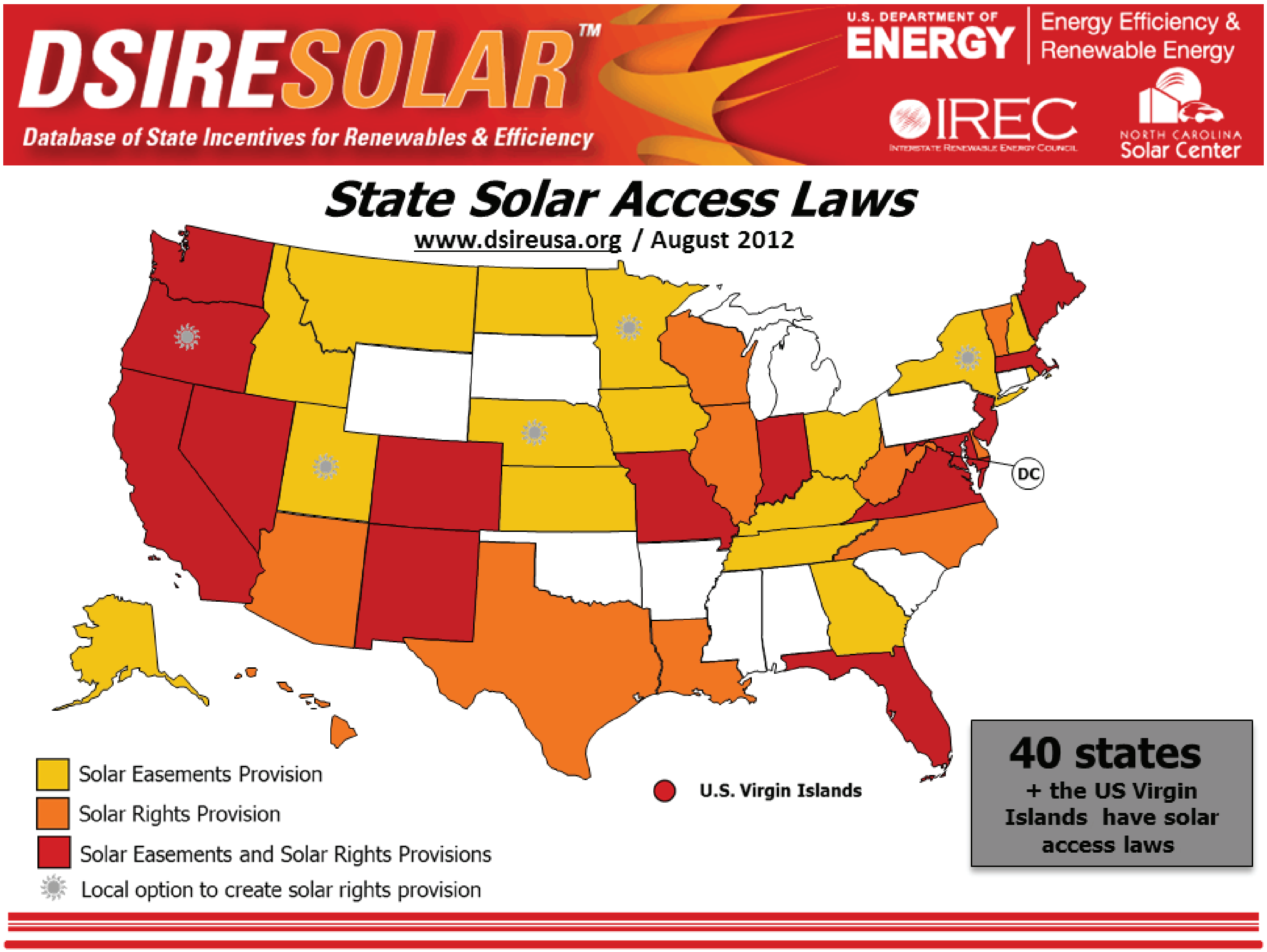
A redwood tree received a "poodle cut" to avoid shading the solar collector on the neighboring property. (Image courtesy of Jim Wilson, The New York Times.*)*

The Dilemma

Urban foresters, other allied professionals, and residents can list many reasons to maintain a mature and healthy tree canopy. Trees provide a wide range of environmental, social, and economic benefits including improving air quality, reducing stress, and increasing property values. Despite these benefits, urban tree coverage is on the decline across the U.S. In fact, according to a 2012 study published in *Urban Forestry & Urban Greening,* 17 of the 20 cities analyzed had statistically significant declines in tree cover (Nowak 2012). Solar energy systems could represent another potential threat to an already increasingly threatened resource.

In order to protect urban forests, advocates have implemented tree-planting and protection campaigns and have developed tools, such as the U.S. Forest Service's i-Tree software suite (www.itreetools.org), to interpret canopy change. Despite these efforts, tree canopy has continued to decline. Solar energy systems contribute to this concern. First, some states require the removal of trees that grow to interfere with solar energy systems, even if the trees were planted prior to the installation of the system. Additionally, many of the alternatives to tree removal recommended by solar proponents, including trimming, pruning, and height restrictions, can reduce the benefits the tree canopy can provide. Finally, areas with high concentrations of solar energy systems may effectively become buffers against future tree plantings. Tree advocates worry about the implications of today's solar installations on the future of the urban forest.

Tree advocates also believe that many questions related to solar installations remain unanswered. For example, while solar advocates have offered solutions for addressing solar during infill development and new construction, impacts to mature trees in older, established neighborhoods have not been addressed. Houses in older neighborhoods are often constructed on smaller lots, which limits the options for tree placement on the lot. Ad-



Solar access laws vary from state to state. (Image courtesy of Database of State Incentives for Renewables & Efficiency [DSIRE].)

ditionally, trees in these neighborhoods have already reached maturity, so few measures can be taken to reduce conflict.

Solar Legislation Relating to Trees

Many communities are taking steps to remove regulatory barriers to solar installation. But even if regulations allow property owners to install solar systems on their properties, shading may limit the efficiency of those systems to a degree that makes their installations economically infeasible.

In the United States, there is no nationwide "right to light," meaning there is no statute, inherent common law basis, or policy at the federal level addressing or affirming solar rights (Staley 2012a). This property-rights issue has been left to the states to resolve, with the result being a hodgepodge of statutes, ordinances, and case law as states take up the issue of solar access rights. Adding the competing interests of tree owners to the mix muddles the issue even further. What happens if access to the sunlight necessary to operate the solar system requires trimming or removal of trees on the individual's property or a neighboring property?

Most states have adopted some type of legislation to ensure solar access rights, but some states have remained silent on the issue. Additionally, legislation varies from state to state and in some states, such as California, legislation has been significantly amended as a result of decisions rendered by state courts. If the rules governing adequate access to sunlight are not predictable and easy to apply, people may be reluctant to invest in solar energy systems, and conflicts will arise that could have easily been avoided. Does a property owner have a "right to light," and should this right be offered without conditions or limitations?

The following are the types of existing legislation states have adopted related to solar in attempts to guarantee reasonable solar access rights in the face of competing interests, such as urban tree growth:

- **Prohibition of Conditions, Covenants, and Restrictions**: These laws prevent homeowners' associations from adopting or enforcing covenants, conditions, and restrictions that bar or place undue burdens on installation of solar energy systems.
- **Solar Easements**: These laws typically allow a landowner to enter into an agreement with an adjacent landowner to ensure that sunlight reaches the property.
- **Local Zoning Authority to Adopt Solar Access Regulations**: These laws permit local zoning authorities to adopt rules and regulations in the permitting and zoning process that preserve solar access, including consideration for shading from other structures or vegetation.
- **Solar Shading**: These laws ensure that the performance of a solar energy device will not be compromised by shade from vegetation on adjoining properties (Kettles 2008).

As of August 2012, 40 states have adopted one or more types of solar access laws (DSIRE 2012). Some of the states with more notable legislation include Wisconsin and California.

Wisconsin is one of the most protective states regarding a resident's right to install and operate a solar energy system, with laws that limit zoning and private land use restrictions on solar and guarantee system owners' rights to unobstructed access to solar resources. Its solar access laws declare vegetation that interferes with solar panels to be a private nuisance, even if the trees predate the solar installation (DSIRE Solar and Wind Rights 2012).

California's solar access law was scaled back in scope after public outcry over its broad reach. Under the original Solar Shade Control Act enacted in 1978, shade cast by a property owner's trees on more than 10 percent of a neighboring solar panel system between the hours of 10 a.m. and 2 p.m. was considered a prosecutable public nuisance. After an unpopular prosecution that required residents to severely cut back redwood trees planted prior to the installation of their neighbor's solar panel system, the act was amended in an attempt to balance the planting of trees and shrubs for shade and visual appeal with increased use of solar energy devices. The 2008 amendment exempts all trees and shrubs planted prior to the time of a solar collector's installation (Anders et al. 2010).

Local Actions Addressing Solar and Trees

The patchwork of statutes, ordinances, and case law at the state level is reflected at the local level. Though many communities have developed urban forest management or green infrastructure plans, tree protection regulations, tree pruning guides, street tree standards, or tree ordinances to protect their urban forests, only a few address both trees and solar installations. These regulations vary greatly; some are more encouraging of solar development whereas others favor protecting the urban forest. Communities who have added these solar regulations to their municipal codes include Ashland, Oregon (§18.70); Madison, Wisconsin (§16.23(8)(a)); Sunrise, Florida (§16-130, §16-172, §16-277); and Greenwich, New Jersey (Ordinance No. 17-2011).

Several types of disputes related to trees and solar energy systems are common at the local level. One relates to property owners who would like to cut down trees on their properties to install solar systems but are prohibited from or charged fees for doing so by local regulations. Another arises when a neighbor of a property with a solar energy system already in place plants trees that are likely to grow to block solar access. A third type occurs when existing trees grow to block a new solar installation on a neighboring property: Do the trees prevail because they were there first, or do they effectively become a nuisance when they grow into the solar access zone?

A number of local disputes over the past few years provides evidence of the growing conflict between solar and trees. City commissioners in Winter Springs, Florida, changed a tree protection policy to allow tree removal for solar devices after a property owner who installed a solar system couldn't fully utilize the system because it was shaded by trees on the property. In Des Moines, Iowa, the Parks and Recreation Board reluctantly voted to cut down 11 mature trees on the town property to accommodate installation of a solar energy system during renovations of the city's library. Several board members noted that they might not have sought the grant that funded the solar energy system installation if they had known it would have required removal of the trees (Alliance for Community Trees 2010). A dispute in California ended up in district court: In

2008 a Sunnyvale couple was ordered to cut twelve-year-old redwood trees on their property so as not to interfere with their neighbor's new solar panels (Barringer 2008). As noted above, community outcry spurred by this case contributed to the decision to amend California's Solar Shade Control Act.

These examples show that to date, when solar energy systems and trees conflict, the trees often lose, even if they were planted before the solar energy systems were installed.

Can Trees and Solar Co-Exist?

The variety of regulations, guidelines, and policies that exist pertaining to solar and trees reveal the challenge communities face in trying to prioritize these two valuable resources. Which is greener? Which is better for the environment? Does it matter which was there first, how many hours the installation is shaded, or how much of the installation is shaded?

Instead of trying to answer questions that result in an outcome where one resource "wins" out over the other, communities should refocus their efforts on taking measures to ensure these interests can successfully coexist. There are a number of recommendations that can assist planners in these efforts:

- Ensure that the right tree is planted in the right place and for the right reason (Staley 2012b). Factors such as how tall a tree will grow to at maturity, how much shade it will likely cast, and in what direction that shade will fall will help determine the optimum placement for minimizing the chance of conflict at a later date. Involve both urban foresters and solar experts in the site plan review process as well as the development of design standards. Ample opportunity exists for making more informed decisions during infill or new construction projects.
- Address urban forests and solar collection together during the planning process. Explicitly acknowledging in the comprehensive plan that trees can be in conflict with solar collection and that efforts must be made to ensure their coexistence provides a basis for addressing this issue in ordinances, development review, and code enforcement (Staley 2012b).
- Invite and encourage urban foresters to become members of local solar advisory committees and councils.
- Consider creating and adopting overlay zoning for "solar access zones" in suitable areas that specifically acknowledges the need to consider plant size to maintain clearance for solar collection (Staley 2012b).
- Amend the subdivision ordinance to require neighborhoods and developments to be laid out in a manner that minimizes conflict between solar and trees. Consider designing future subdivisions as solar subdivisions that have streets, buildings, and roofs oriented to receive sunlight.
- Replace removed trees where possible, and track tree removals to ensure there is no net loss in trees.
- Educate citizens as to the benefits of both solar and trees, and increase their awareness of best practices of sensible planning to avoid shading and ensure that solar and trees can coexist.
- In instances where a solar installation would result in the removal of mature trees, encourage or require other energy conservation strategies first. Additionally, encourage or require homeowners to prune trees before permitting removal.
- Actively identify the best places to locate solar in a community, and direct installations to these areas. These include already developed areas and areas where existing infrastructure is already in place, such as parking lots, roads, brownfield and greyfield sites, landfills, and big-box stores. These areas should be selected over areas that are heavily forested or other areas where conflicts are likely.
- Incorporate planning software and tools, like i-Tree and solar maps, that provide relevant data on tree growth, urban forest benefits, and shading into the project review process (other freeware tools include Google Earth, Sketchup, and Paint.NET). Train planning staff or hire an arborist to conduct these analyses during the review process.
- Stay on top of solar technology. Encourage the development of smaller, more efficient systems, and encourage or require the selection of systems that are least impacted by shading (when shading is unavoidable).

Solar and Urban Redevelopment

A potential competing interest with solar energy systems that remains largely overlooked is urban redevelopment. Many communities seek to concentrate development in targeted areas like downtowns or transit-oriented developments (TODs) in an attempt to reduce vehicle miles traveled (VMT), provide more efficient services, and to provide transportation and housing alternatives. This often means changes to regulations, including height restrictions, to accommodate future growth. At the same time, these are the same areas where communities are often encouraging solar projects. Just as shade cast by a tree over a solar energy system can reduce the installation's efficiency, so can the shadow of a tall building. As targeted areas redevelop, the possibility for solar conflicts rises.

As discussed above, many states have adopted legislation in attempts to ensure that existing solar installations have access to an adequate amount of sunlight. Even the states with notable "right to light" legislation have not specifically addressed the issue of solar and urban redevelopment, however. Solar maps, developed by some communities to help property owners determine the solar potential of their properties, can account for shade from existing neighboring buildings, but cannot predict impacts that result from redevelopment that has not occurred.

To date there have been little to no documented disputes in the U.S. Besides a handful of property owners attempting to block development applications at local board meetings, the issue has been nonexistent. But the potential for conflicts in the future is high. If the solar versus trees debate is any indication, it is likely that most communities have not thought about the impact that solar regulations could have on their urban areas or their redevelopment goals. If a community is unable to build up, it could be limiting its ability to meet future population demand and combat sprawl. It could also be reducing its ability to provide the density necessary to support its public transportation system. Developers may also argue that without additional square footage the costs of redevelopment in these areas outweigh the investment.

Additionally, it is unclear what would happen if a property owner built a building or addition that impacted an existing solar system. Removing a building (or floors of a building) in a densely developed area will be much more difficult and costly than removing trees and other vegetation. Some communities with strong solar access laws may impose high costs to mitigate impacts. Others may not have guidelines or regulations in place for compensation. Finally, many areas targeted for redevelopment are located immediately adjacent to residential neighborhoods of much lower density where the likelihood of shading is relatively high. This gives another piece of ammunition to neighborhood advocates looking to prevent higher-density developments in proximity to their neighborhood (Feldman 2009).

These risks and uncertainties could discourage, delay, or prevent development activity or solar installations in areas targeted for increased future redevelopment. Communities need to think through the potential tradeoffs and develop strategies to

Resources: Solar and Trees

A number of published works have examined local approaches to solar access generally and conflicts with trees in particular, including the following:

- "A Comprehensive Review of Solar Access Law in the United States: Suggested Standards for a Model Statute and Ordinance" (Colleen Kettles, Solar America Board for Codes and Standards, 2008; www.solarabcs.org/about/publications/reports/solar-access/pdfs/Solaraccess-full.pdf). This publication (pages 10–11) identifies the recommended elements of solar access legislation.
- "Trees and Solar Power Coexisting in an Urban Forest Near You" (Dan Staley, 2012; http://danstaley.net/Staley%202012%20Trees%20And%20Solar%20Power%20Coexisting%20in%20an%20Urban%20Forest%20Near%20You%200012%20WREF%20Solar%202012%20FINAL.pdf). This paper describes several innovative policies to facilitate the successful coexistence of urban trees and rooftop solar energy collection.
- "California's Solar Rights Act: A Review of the Statutes and Relevant Cases" (Scott Anders et al., University of San Diego School of Law Energy Policy Initiatives Center, 2010; www.sandiego.edu/epic/research_reports/documents/100426_SolarRightsAct_FINAL.pdf). This resource discusses California's solar access legislation and the current exceptions from its provisions.
- "My Tree Versus Your Solar Collector or Your Well Versus My Septic System? – Exploring Responses to Beneficial but Conflicting Neighboring uses of Land" (R. Lisle Baker, Boston College Environmental Affairs Law Review, 2012; http://lawdigitalcommons.bc.edu/ealr/vol37/iss1/2/). This law journal article reviews legal cases illustrating historic solar tree conflicts in the U.S.
- "A Western Street Tree Management Symposium Presentation: Integration of the California Solar Act with Urban Forestry" (Dave Dokter, City of Palo Alto Planning Department, 2010; www.streettreeseminar.com/ppt/Dockter.pdf). This presentation looks at shading studies and proactive measures to plan buildings and craft ordinances that harmonize urban forestry and solar goals.

address conflicts before they arise. This may involve determining prime areas for both solar installations and redevelopment and identifying them for the public through the use of tools like overlay districts. When these areas overlap, communities could develop interface (or zone of transition) design guidelines or standards that specifically address the impacts of massing on existing solar installations. Additionally, communities could modify solar-access zone provisions to address redevelopment in addition to trees. It should be noted that these recommendations will be most effective in areas slated for large-scale redevelopment. Situations of lot-by-lot redevelopment will be much trickier. With no solar access laws in the U.S. specifically addressing this issue, communities should also consider looking internationally to see how other countries' solar access laws for urban areas are evolving.

Conclusion

While promoting the installation of solar energy systems, communities are increasing their potential for conflict with other community interests including historic preservation and tree protection. To date, few communities are considering the effects the decisions made in support of solar can have on these other community interests. Planners are uniquely positioned to spearhead efforts to determine mutually beneficial solutions to ensure these interests can successfully coexist in the future. They can lead tough community discussions, bring the appropriate stakeholders to the table, develop relevant guidelines and regulations, and educate residents on all of the angles of an identified interest. Instead of having to choose between competing interests, communities and planners should undertake these efforts to help them obtain the truly sustainable futures they desire.

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Cover: A solar panel system was installed on the rear elevation of this historic property in the Heritage Hill Historic District of Grand Rapids, Michigan. By locating the system in the rear of the property, the views from the public right-of-way remain preserved. *(Image courtesy of Kimberly Kooles, N.C. Solar Center.)*

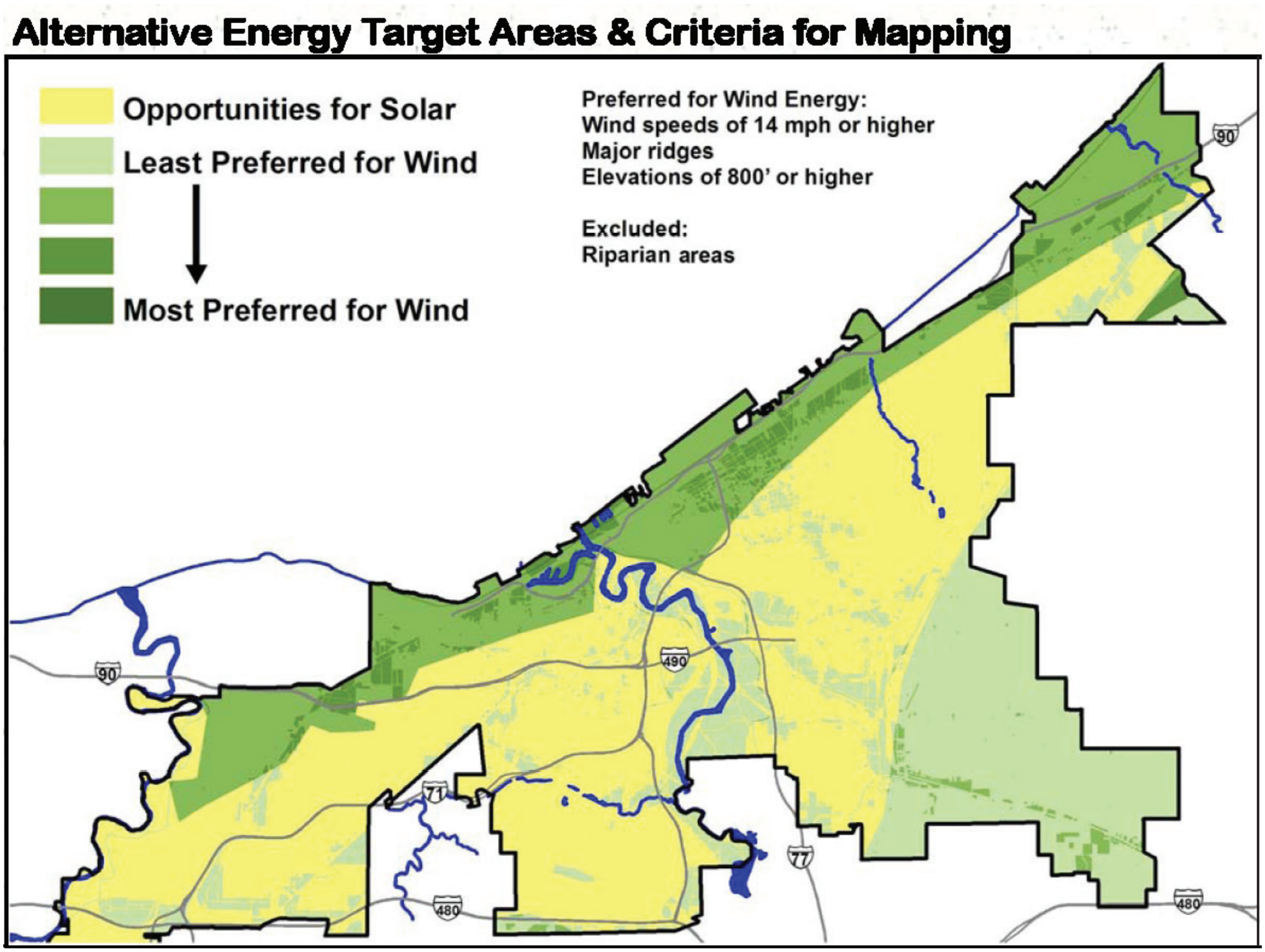
Recycling Land for Solar Energy Development

A growing number of cities and counties are committed to becoming more environmentally, economically, and socially sustainable. However, many of these communities face pressing economic challenges that frustrate efforts to make progress toward sustainability goals. Those that have suffered decades of population and job losses, as well as those especially hard hit by the Great Recession, are struggling with high numbers of vacant properties, be they former industrial sites, abandoned houses, or shuttered strip retail. While many of these properties will eventually find new life through reoccupancy or conventional redevelopment, alternative reuse options may be the best current—if not the only—solution for a glut of brownfields, greyfields, and redfields (see Glossary). One of the most promising of these alternative reuse options is solar energy development, and planners can play a crucial role in helping their communities evaluate and embrace solar energy for vacant land management.

In recent years numerous planners, public officials, and policy advocates have pointed to renewable energy projects as possible strategies for managing previously developed, but currently vacant, land. Building off this theme, the U.S. Department of Energy coined the term *brightfield* to describe brownfield reuse for either solar energy production or solar technology manufacturing (U.S. DOE 2005). In many communities solar energy projects are perceived as better neighbors, and are therefore less controversial, than other renewables such as wind, geothermal, and biomass, which may be less adaptable to site constraints, may be less compatible with other on-site uses, or may have greater potential impacts on adjacent properties. The relative popularity of solar projects in comparison to other renewables can also be attributed to the prevalence of the solar resource and, in some regions, incentives for solar technology.

Recycling land for solar energy projects is consistent with sustainable development principles. Whether the energy is used on site or sold to the grid, solar redevelopment reduces the demand for fossil fuels and, by extension, the production of greenhouse gas emissions. Construction and installation work creates demand for local green-collar jobs, and in neighborhoods with high percentages of vacant properties, solar installations can reduce blight and improve appearances. When a solar redevelopment project involves cleanup of a contaminated site, it has the dual benefit of decreasing public health risks and repairing damage to the natural environment. Furthermore, large-scale reuse projects provide an alternative to developing greenfield sites, and solar redevelopment at all scales is well positioned to take advantage of existing infrastructure and public services.

While it is true that ground- or building-mounted solar panels can be a good fit for vacant properties of all sizes in a wide range of contexts, serious barriers to recycling land for solar energy production do exist. These barriers may include incom-



This map, prepared by Re-Imagining a More Sustainable Cleveland *'s Alternative Energy working group, shows that most of the city is climactically and topographically suitable for solar projects. (Image courtesy of City of Cleveland.)*

plete or inaccurate information about available sites, inadequate solar access, outdated or confusing development regulations, extensive on-site contamination, and insufficient project financing. The purpose of this briefing paper is to provide planners, public officials, and engaged citizens with an overview of considerations and strategies for cities and counties hoping to promote or pursue solar energy projects on vacant properties with little current demand for reoccupancy or conventional redevelopment.

Community Roles in the Solar Redevelopment Process

The basic process for any solar development project involves six steps: (1) identifying potential sites, (2) assessing site constraints, (3) designing and securing development approval, (4) construction, (5) operations, and (6) decommissioning (U.S. EPA 2012). When a project is sited on previously developed land, the presence or potential presence of contamination can affect each step in this process.

With these ideas in mind, there are a number of different roles that cities and counties may play in promoting solar redevelopment. These roles include acting as a developer or development partner, providing technical assistance or financial incentives, establishing effective regulations and review processes, and purchasing power produced by solar projects.

Each step in the development process presents opportunities for communities interested in promoting solar installations on vacant properties. Furthermore, for planners and public officials, there is also a critical step zero—helping the community develop a vision related to solar redevelopment. The sections below highlight specific considerations and strategies for each stage of the development process.

Developing a Community Vision

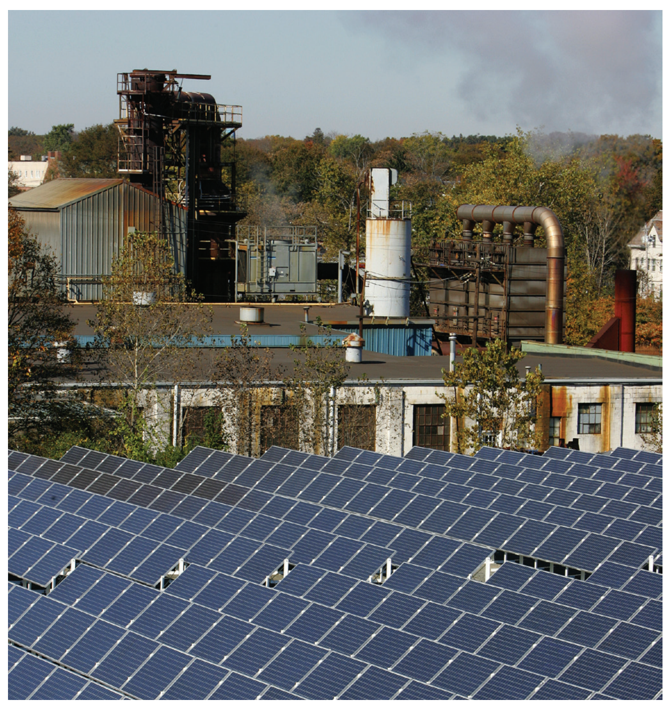
Perhaps the most important opportunity that planners and public officials have for promoting solar redevelopment comes through the process of developing clear visions related to renewable energy on previously developed land. By articulating goals and objectives related to recycling land for solar energy projects, cities and counties can signal to residents and developers alike that solar redevelopment is a desirable interim or long-term use for vacant properties. This process may be part of a long-range communitywide planning initiative, such as a new or updated comprehensive plan (as described in the third briefing paper in this series, "Integrating Solar Energy into Local Plans,") or it may be in the context of a strategic planning initiative focused on formulating strategies for vacant land management.

One example of a strategic planning initiative is *Re-Imagining a More Sustainable Cleveland*, led by Neighborhood Progress, Inc., a community development intermediary, in collaboration with the Cleveland City Planning Commission and Kent State University's Cleveland Land Lab, with funding from the Surdna Foundation. The goal of the planning process was to explore reuse strategies for vacant parcels located outside of the priority development areas identified in the city's comprehensive plan. The final report includes a discussion of the benefits of reusing vacant land for solar installations along with policy recommendations to incentivize the generation and use of renewable energy.

After a community has clearly articulated a vision for solar redevelopment, it is important to check existing development regulations and design guidelines for consistency with the adopted goals and objectives. For more information on this step, see the fourth briefing paper in this series, "Integrating Solar Energy into Local Development Regulations." Planners and public officials may need to amend development regulations in order to permit solar installations as a primary use of land in zoning districts targeted for solar redevelopment. This may be accomplished either by adding solar energy systems to existing use lists or by adopting a new district or overlay to facilitate redevelopment. Clear use permissions, development standards, and design guidelines help property owners and financiers understand what types of projects will be approved in specific locations.

Some communities go beyond simply sanctioning solar installations in their development regulations by offering development incentives for projects that include green design features. For example, Bloomington, Indiana, permits increased density and waives filing fees for projects that incorporate sustainable development practices, such as on-site renewable energy production (Unified Development Ordinance Section 20.05.049).

Apart from development regulations and incentives, communities may adopt green power–purchasing requirements in order to boost the local market for solar energy production. Conventionally, a green power–purchasing requirement establishes a minimum percentage of energy that municipal users must obtain from renewable sources. For example, the City of Lansing, Michigan, has committed to purchasing 20 percent of all of its power from renewable sources by the year 2020 (Lansing 2007). Cities and counties could also use green power–purchasing requirements in a more targeted fashion by giving preferential consideration to power generated as a result of solar redevelopment projects.



Brockton Brightfields is a 460 kW grid-integrated solar installation on the site of a former manufactured gas facility. (Image courtesy of Brockton Brightfields, City of Brockton, Massachusetts; SCHOTT Solar.)

Identifying Potential Sites

The one universal precondition for solar redevelopment is access to sunlight, and there are a number of conditions affecting this access on any given site. In the most general sense, latitude and regional climate dictate the gross quantity and quality of sunlight available to a certain parcel; meanwhile, on-site or nearby topographic features, trees, and buildings can all limit the amount of sunlight available at a specific location. This is discussed in more detail in the fifth briefing paper in this series, "Balancing Solar Energy Use with Potential Competing Interests." At the macro-scale, EPA provides national and state maps that show how the quality of solar resource varies across large areas, and at the micro-scale, the National Renewable Energy Laboratory's (NREL) online PV Watts calculator (www.nrel.gov/rredc/pvwatts/) estimates monthly and annual energy production and value based on user-selected location and system characteristics. Beyond these tools, a number of states and local communities have created their own solar mapping tools to help identify suitable locations for solar installations; see the second briefing paper in this series, "Solar Mapping," to learn more about these tools.

While EPA brownfields lists are a good start for communities trying to identify opportunity sites, most communities have numerous vacant parcels that don't appear on federal lists. Having a complete inventory of vacant properties helps communities match potential developers to available sites. Because relatively few cities and counties have complete and up-to-date information about vacant properties, it is important for planners and public officials to evaluate existing data sources such as federal, state, and local brownfield lists, parcel-based information systems maintained by the local tax assessor or code enforcement official, and neighborhood-specific inventories maintained by community-based organizations. Ultimately, though, it may still be necessary to conduct a field survey to fill in the gaps or improve the quality of existing data.

One of the most effective tools for any vacant land management strategy is a searchable database that integrates parcel-based information from various sources with geographic information systems (GIS) technology. Perhaps the most sophisticated example of this type of database is the Northeast Ohio Community and Neighborhood Data for Organizing (NEO CANDO) system (http://neocando.case.edu/cando/index.jsp), maintained by Case Western Reserve University in Cleveland. However, even simple databases can be used to steer potential developers toward opportune sites. In addition to identifying the solar potential of vacant properties, communities can also use parcel-based information systems to document and track ownership, liens, foreclosure actions, and code violations that may complicate redevelopment.

Another way that planners and public officials can assist with site identification is by helping potential developers understand the comprehensive plan designations and zoning standards that apply to specific vacant properties. This includes explaining to interested developers what types of projects would be allowed by right or with a discretionary approval on any given property. Along with the other types of parcel-based information discussed above, planning and zoning information can help developers make an initial determination about whether or not to move forward with a site-specific analysis of constraints.

Assessing Site Constraints

Apart from having adequate access to sunlight, there are a number of site-specific factors that influence the feasibility of solar redevelopment on a given parcel. Structures, trees, surface water, or steep slopes can all affect the amount of usable area for a solar installation, and grid-connected systems typically depend on proximity to existing transmission and distribution lines.

When considering solar projects on brownfields, one of the biggest potential barriers to solar redevelopment is the fear of liability related to the presence, or potential presence, of contamination. Given this fear of liability, there are two basic approaches that cities and counties can take to facilitate redevelopment: (1) proactively assess the potential or presence of contamination on vacant sites or (2) help potential developers understand and navigate site investigation and cleanup processes.

Federal and state brownfields programs typically require compliance with a formal site-investigation process referred to as All Appropriate Inquiry (AAI) to be eligible for funding and liability defenses. The process begins with a Phase I Environmental Site Assessment. This assessment involves a review of existing records for the site, interviews with current and former owners and occupants, and a visual inspection using photographs and maps. In many cases there will be no significant contamination and, therefore, no costly cleanup required for reuse. In cases where a Phase I assessment indicates the presence or likely presence of contamination, site investigators must initiate a Phase II Environmental Site

Assessment to gauge the specific nature and extent of the problem. This assessment involves soil and water sampling and analysis.

When cities and counties proactively assess sites in their ownership, planners and public officials can then communicate findings to potential developers up front. Additionally, local governments may provide funding or technical assistance to private owners to assess their own properties. That way, if contamination is present, stakeholders can explore cleanup options before investing in project design.

NREL developed a decision tree for Richmond, California, to help the city assess the potential for solar energy projects on all known brownfield sites. The decision tree addressed site characteristics, constraints related to ownership and contamination, and financial considerations (NALGEP 2012). NREL and EPA subsequently created a general solar decision tree, available through EPA's Re-Powering America's Lands website (www.epa.gov/oswercpa/), to help all communities and interested parties assess the solar redevelopment potential of any site.

Depending on the type and extent of contamination, there may be a range of possible cleanup alternatives. In many states the end use of the site determines the extent of remediation required (U.S. EPA 2011). These "risk-based" standards typically require more extensive cleanup for schools and residences than for end uses that pose little risk to humans. By extension, if a solar redevelopment project does not involve residential, recreational, or commercial uses, the remediation bar will likely be lower than for projects that do include those other uses. It may even be possible to use a solar installation on the site to power cleanup activities.

Because cleanup standards and alternatives can be opaque to potential developers with no background in environmental science, planners and public officials can play valuable roles by simply connecting these developers to additional information about relevant state programs and local cleanup experts. A community may choose to take a more active role by assigning the local brownfields program manager or a staff planner to act as a case manager for certain sites, or by developing a guide to help potential developers evaluate potential site constraints. For example, the New York City Brownfield Partnership (www.nycbrownfieldpartnership.org) connects potential developers to engineers, environmental consultants, land-use planners, financial analysts, and environmental attorneys in the brownfield industry. Through this program, partnering professionals and

This solar installation on a Superfund site in Livermore, California, used concentrated sunlight to destroy volatile organic compounds in the groundwater. (Image Courtesy Warren Gretz/NREL.)

organizations provide free consulting to parties seeking information about liability and remediation for contaminated properties.

When considering solar projects on redfields, title issues can complicate redevelopment. Potential developers may be dissuaded by delays and uncertainty associated with securing permission from bank owners and lien holders for site access or property transfer. Some cities and counties have facilitated redevelopment of financially distressed properties by creating land-bank entities to centralize acquisition and disposition efforts.

While the authority and efficacy of land banks varies from state to state, the Neighborhood Stabilization Program, authorized by the Housing and Economic Recovery Act of 2008, and the subsequent American Recovery and Reinvestment Act of 2009 opened new doors for land banks to acquire foreclosed properties. The Genesee County Land Bank Authority in Flint, Michigan (www.thelandbank.org), and the Cuyahoga Land Bank in Cleveland, Ohio (www

.cuyahogalandbank.org), are both notable examples of land banks that have had success clearing titles and ensuring redevelopment in line with community goals.

Designing and Securing Development Approval

There are a range of solar redevelopment options depending on site characteristics and market potential. The size of the parcel, the relative market strength of its location, the underlying zoning, the parcel's solar access, and the presence of contamination can all shape the type of solar energy project appropriate for a given property. Large parcels in industrial districts with abundant access to sunlight and little conventional redevelopment potential may be ideal for utility-scale solar installations. Alternately, vacant lots dispersed throughout a residential neighborhood may be appropriate for a community solar or virtual net-metering project that provides power directly to nearby homes. And a single vacant residential or commercial property may be a good candidate for a third-party ownership arrangement that provides some supplemental income while awaiting a more permanent reuse.

Many cities and counties subject all large solar installations to a conditional or special-use permitting process. While these discretionary reviews are often necessary to evaluate the likely impacts of the project on the community, discretionary development review costs potential developers both time and money. For this reason, cities and counties that can streamline the development review process will be minimizing a major barrier to solar redevelopment. Communities may elect to further incentivize large-scale solar redevelopment by reducing development review or impact fees or by entering into a development agreement that lowers local property taxes or sets a fixed annual payment in lieu of taxes in order to help developers predict and amortize project costs.

Even when a solar project is permitted by right, high permitting fees and delays associated with securing building and electrical permits can pose barriers to smaller-scale projects. In recognition of these facts, cities such as San Jose and Philadelphia have developed streamlined solar permits that replace separate building and electrical permits. Both of these cities also provide guidance materials through department websites to help potential developers navigate the permitting process.

Many communities have leased or donated land to solar redevelopment projects that sell power to the municipality or to the local utility. For example, the City of New Bedford, Massachusetts, has agreed to let ConEdison Solutions install solar panels on multiple city-owned sites, including schools, municipal buildings, and brownfields, by 2013. The city will purchase the power generated by these rooftop- and ground-mounted systems, and at buildout the distributed network is expected to produce enough electricity for 1,500 homes (Lang 2011).

Cities and counties interested in leasing land for solar redevelopment typically solicit bids using a request for proposals (RFP) process. Through the RFP the community can outline goals for site reuse, specify a lease period, and stipulate conditions for site access (The Solar Foundation 2012).

Distressed neighborhoods with high numbers of residential vacancies and weak market demand may benefit from solar projects that aggregate power produced over multiple lots. In areas with multiple tax-foreclosed properties, it may be possible for cities and counties to partner with a community-based organization to develop a community solar project that offsets power purchased by nearby residents from the local utility. However, because few states have explicitly enabled these kinds of virtual net-metering arrangements, it is important for planners and public officials to seek advice from a knowledgeable attorney before soliciting proposals.

Construction

The construction phase is of obvious importance to cities and counties committed to acting as developers or development partners for solar projects on public land. This is where communities can witness their visions come to life, and over the past several years there have been numerous success stories of communities transforming contaminated properties into solar farms.

To illustrate, the City of Rifle, Colorado, entered into a partnership with SunEdison, a global solar-power producer, to redevelop a former uranium-processing facility as a 1.7-MW solar energy installation to power the city's new regional wastewater reclamation facility. As a result of the Uranium Mine Tailings Remediation Control Act (1978), DOE had capped radioactive materials by 1996 and is in the process of treating the groundwater contamination through natural flushing and institutional controls. SunEdison covered all development costs, and the city agreed to purchase the electricity produced on site for the next 20 years. Siting the project on contaminated, city-owned land will save taxpayers an estimated $2 million in project development costs (U.S. EPA 2009).

Cities and counties not acting as developers or development partners can support the construction phase of solar redevelopment by providing financial assistance for cleanup activities or solar equipment. This assistance may be in the form of grants or low-interest loans to cover cleanup costs or rebates for solar installations. For example, the City of Oakland operates a sophisticated local brownfields program that stresses risk-based standards and uses a revolving loan fund to assist with remediation activities on brownfield sites, and across the bay, the City of San Francisco offers sizable rebates for solar energy systems installed on residential, commercial, and institutional properties.

Alternately, planners and public officials can play important roles by sharing information with potential developers about state and federal assistance programs related to brownfield redevelopment or solar installation. Apart from EPA and state brownfield-assistance programs, there are numerous states that offer rebates or loans to subsidize the cost of solar energy systems, either in isolation or in the context of comprehensive energy-efficiency improvements. The Database of State Incentives for Renewables & Efficiency (DSIRE; www.dsireusa.org) is an excellent starting point for tracking current assistance programs active in each state.

Operations

In many communities the interconnection process can present a major hurdle for solar redevelopment projects. Cities and counties can minimize this barrier by educating planning and building staff about local interconnection procedures, and communities with municipal utilities can streamline the process by developing standardized interconnection agreements. Examples of municipal utilities with standard agreements include the Sacramento Municipal Utility District in California, Colorado Springs Utilities in Colorado, and Fort Pierce Utilities Authority in Florida.

Once systems are operational, municipal utilities can extend ongoing support to solar redevelopment projects by purchasing power and renewable energy certificates (RECs) from producers. States (and some municipal utilities) enable RECs by adopting renewable portfolio standards (RPS). In states or municipal-utility service areas with renewable energy requirements, RECs are administrative instruments that represent the positive environmental and social benefits of renewable electricity generation. Where enabled, utilities can purchase RECs to comply with RPS targets.

For example, the City of Westfield, Massachusetts, has entered into a lease agreement with Axio Power, Inc., (now SunEdison) to develop a solar installation on a closed municipal landfill. The municipal utility, Westfield Gas and Electric Light Department, has agreed to purchase the power produced by the facility and then deliver it to municipal facilities at a discounted rate (Moriarty 2012).

Decommissioning

The decommissioning phase of the solar redevelopment process is where the life of a solar energy system comes to an end. But instead of just seeing this phase as an endpoint, planners and public officials can also think of decommissioning as a prelude to a new redevelopment opportunity.

All solar energy systems have a functional lifespan. While most new systems are designed to last at least 25 years, most communities expect them to exist indefinitely. The risks posed by obsolete systems are twofold: (1) rooftop equipment in a state of severe disrepair may fall or be blown onto neighboring properties during a severe wind event; (2) decommissioned rooftop and ground-mounted systems may detract from community appearance and contribute to blight if left inoperable and open to the elements. For these reasons, it makes sense for cities and counties to help property owners work through options for removing or replacing decommissioned solar-energy systems.

Planners may partner with local environmental or public works officials to develop educational guides that explain local options for safe disposal of obsolete systems. Because some thin-film systems contain small amounts of toxic materials, inappropriate disposal may contribute to the creation of a new brownfield. In many cases, safe disposal will involve either returning the system to the original manufacturer or contracting with a specialized recycler.

In order to encourage proper decommissioning, communities may add provisions related to unused or inoperable systems to their development regulations. For example, the City of Minneapolis gives owners 12 months to remove abandoned or unused freestanding solar-energy systems (§535.840(c)(4)).

Decommissioning also provides an opportunity for planners and public officials to brief property owners on current incentives for replacement systems. In cases where development regulations or permitting processes have changed since the initial installation, planners can also help owners understand

Glossary

Brownfield: Any vacant or underused real property where redevelopment or reuse is complicated by the presence or perceived presence of contamination.

Brightfield: Any brownfield that has been redeveloped with a solar energy generation or manufacturing project.

Greenfield: Any farmland or open area where there has been no prior industrial or commercial development.

Greyfield: Any previously developed commercial property that is underused due to economic obsolescence.

Redfield: Any commercial development in foreclosure or facing severe financial distress.

current application and review processes. If neighborhood market conditions have improved significantly since the initial installation, there may also be opportunities for planners and public officials to help owners explore conventional redevelopment options that still integrate solar technologies. For example, new structures may present opportunities for solar-oriented site design and building-integrated systems.

The Importance of Community Engagement

As discussed above, planners and public officials play crucial roles in engaging the public in developing community visions for solar redevelopment. However, the importance of community engagement throughout the redevelopment process cannot be overemphasized. In communities where solar installations are not common, there may be concerns about the impacts of solar projects on nearby properties. Planners and public officials have a responsibility to keep abreast of common concerns and misconceptions and be able to provide correct and current information in response. For more information on responding to community concerns about solar and taking a proactive approach to educating residents about solar, see the first briefing paper in this series, "Solar Community Engagement Strategies for Planners."

When a solar redevelopment project involves a brownfield, there is a greater potential for controversy and opposition. Depending on project specifics, residents and business owners may worry about the effect of the project on public safety or have concerns about preserving community character. Apart from simply communicating the benefits of the project, planners and public officials have a responsibility to share cleanup plans and progress reports with all stakeholders.

Conclusion

The idea of recycling land for solar energy projects has gained momentum in recent years. Solar redevelopment reduces the demand for fossil fuels and the production of greenhouse gas emissions, and in communities with a large surplus of previously developed but currently vacant land, solar installations can be an effective strategy for controlling blight. However, given the capital investment required for solar equipment and the risks associated with contamination on brownfield properties, potential developers may shy away from redevelopment opportunities unless cities and counties are able to address potential barriers at each step of the redevelopment process. This means planners and public officials have opportunities to help their communities develop visions for supporting solar development and then to craft regulations, incentives, and programs to implement these visions.

This briefing paper was written by David Morley, AICP, APA's Planning Advisory Service Coordinator.

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Cover: Exelon City Solar, the largest urban solar plant in the United States, is located on a 41-acre brownfield in Chicago's West Pullman neighborhood. *(© Image courtesy of Chicago City Solar / Northwestern University.)*

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