SUPPLEMENTAL DOCUMENTS FOR CEQA APPEAL

312 GREEN STREET, SAN FRANCISCO

Solar Shade Study (Pages 1-11)

Shade Study Consultant Biography (Page 12)

Shade Study Consultant Qualifications (Pages 13-15)

Solar Rights Act (Pages 16-53)

CA Shining Cities (Pages 54-116)

Neighborhood Density Ratios (Pages 117-118)

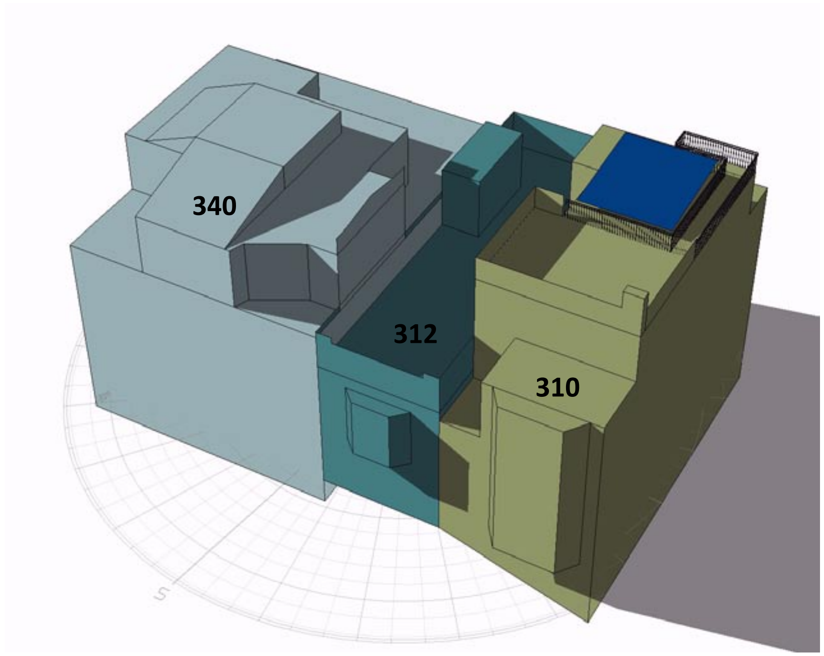
PHOTOVOLTAIC ARRAY SHADING STUDY

310 GREEN STREET
AUGUST 2014

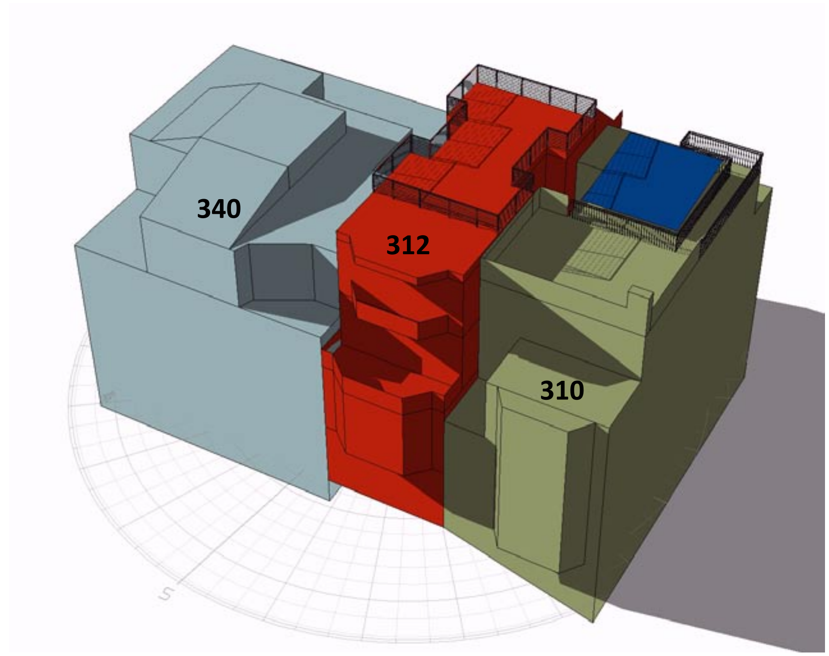
3D MODELING OF THE EXISTING AND PROPOSED CONDITIONS

The existing as well as proposed conditions were model in the building performance analysis software Ecotect. The model was created based on the architectural drawings submitted by the sponsor of the proposed project at 312 Green Street, as part of the 311 notice.

The existing solar array located on the roof top of the property at 310 Green Street was also modeled.



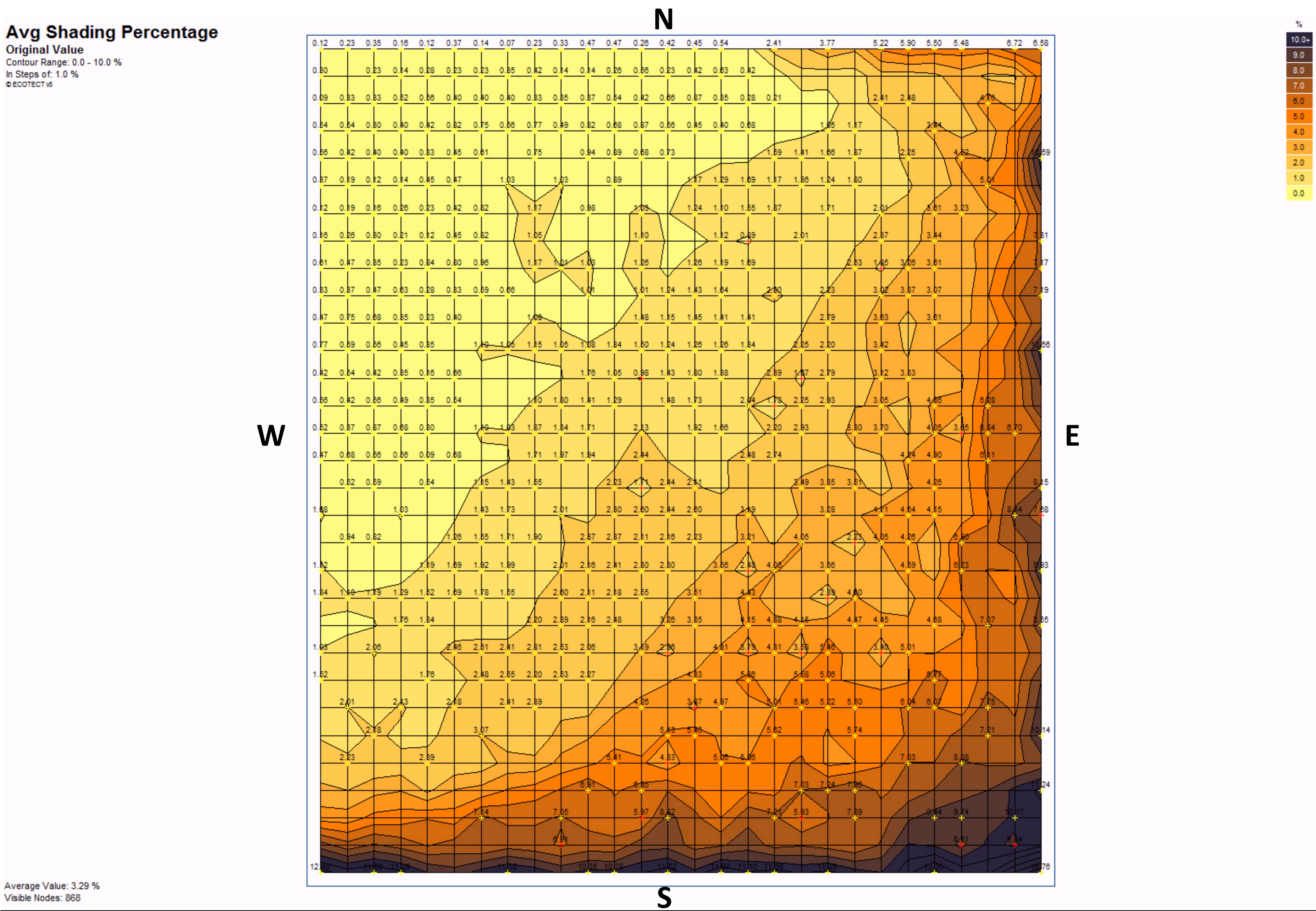
EXISTING CONDITIONS



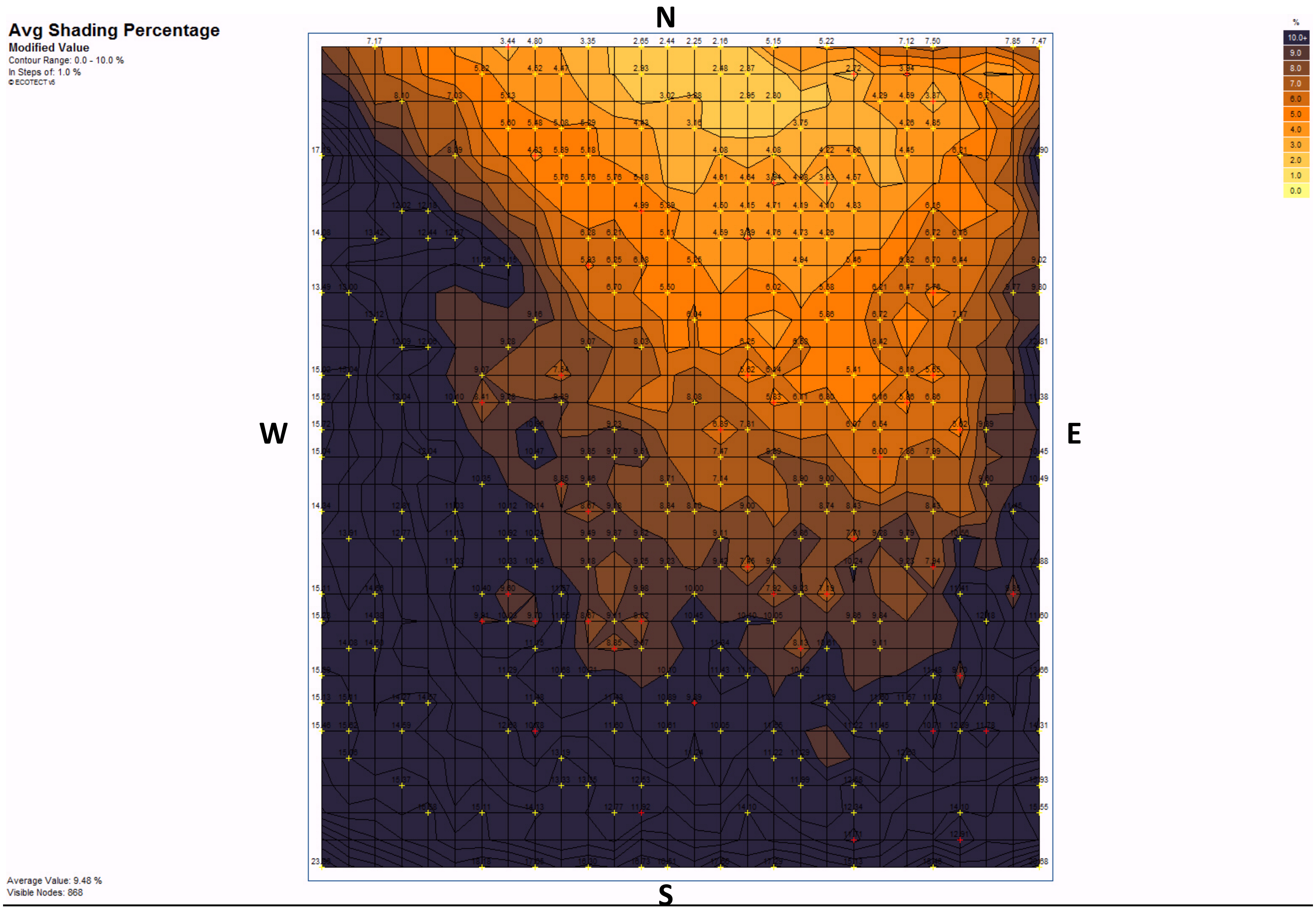
PROPOSED CONDITIONS

A shading analysis was done for various times of the year (June 21st, September 21st and December 21st) to assess the degree of new shading over the existing photovoltaic array at 310 Green Street.

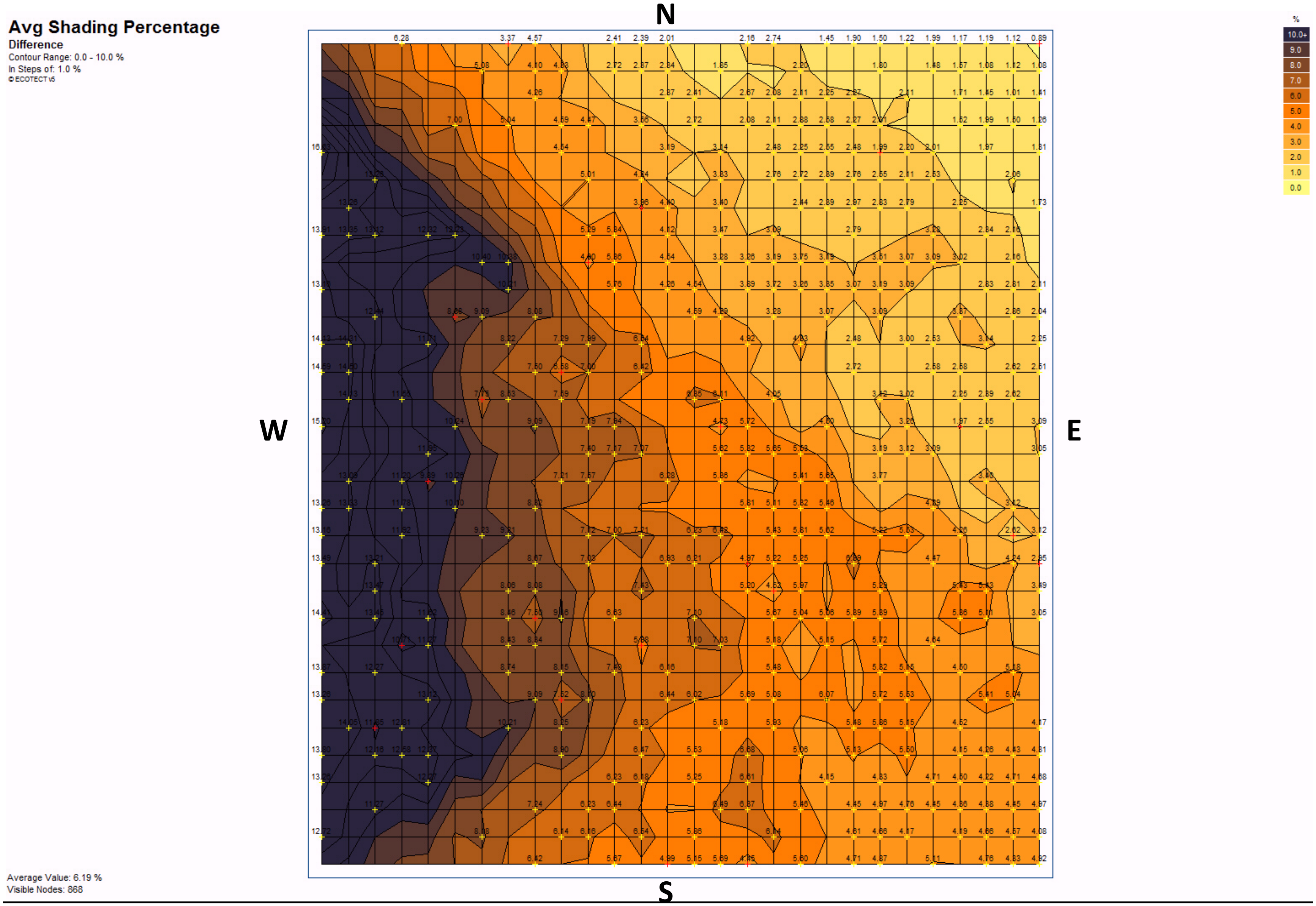
EXISTING CONDITIONS SOLAR ARRAY YEARLY AVERAGE OVERSHADOWING = 3.29%



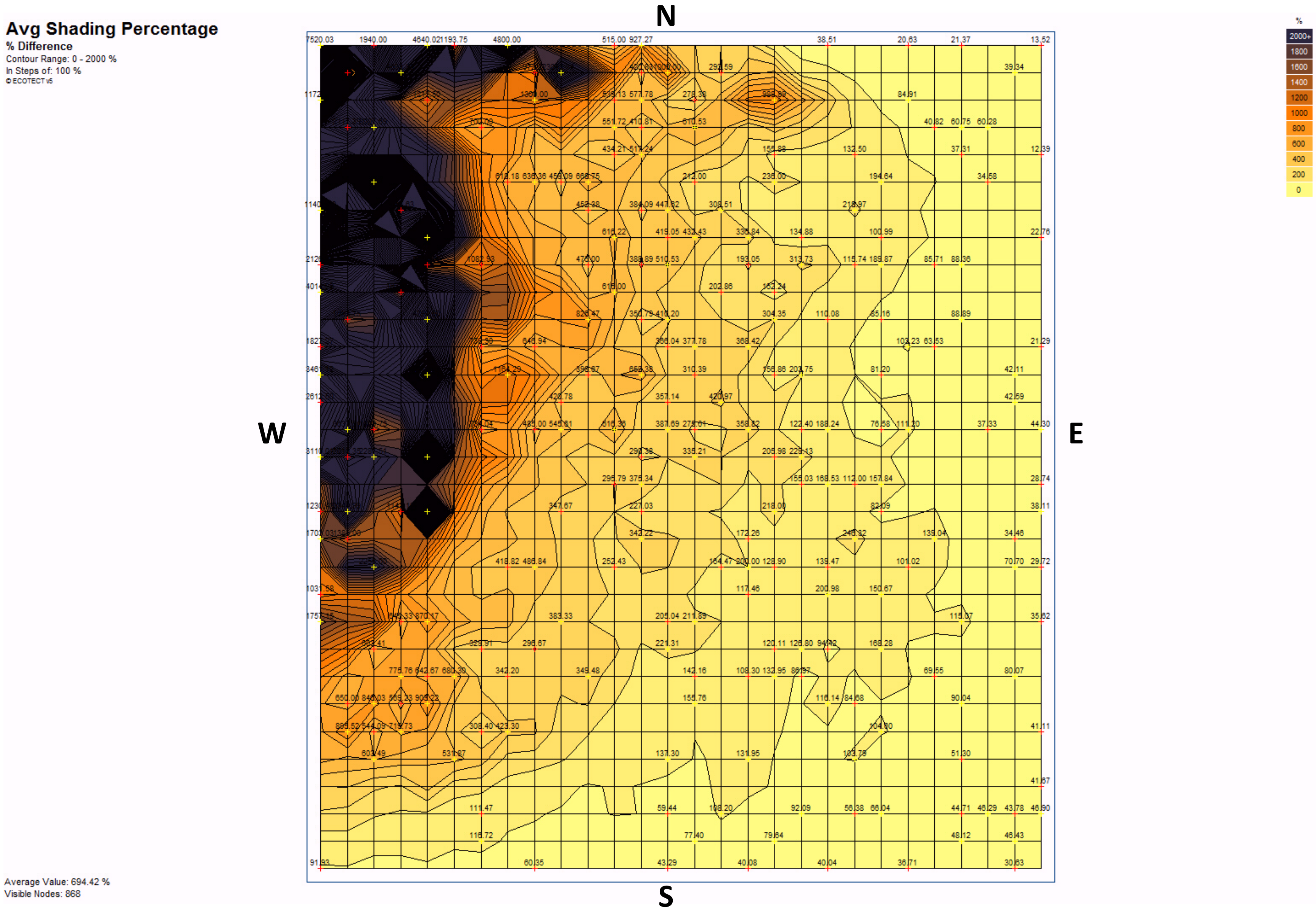
PROPOSED CONDITIONS SOLAR ARRAY YEARLY AVERAGE OVERSHADOWING = 9.48%



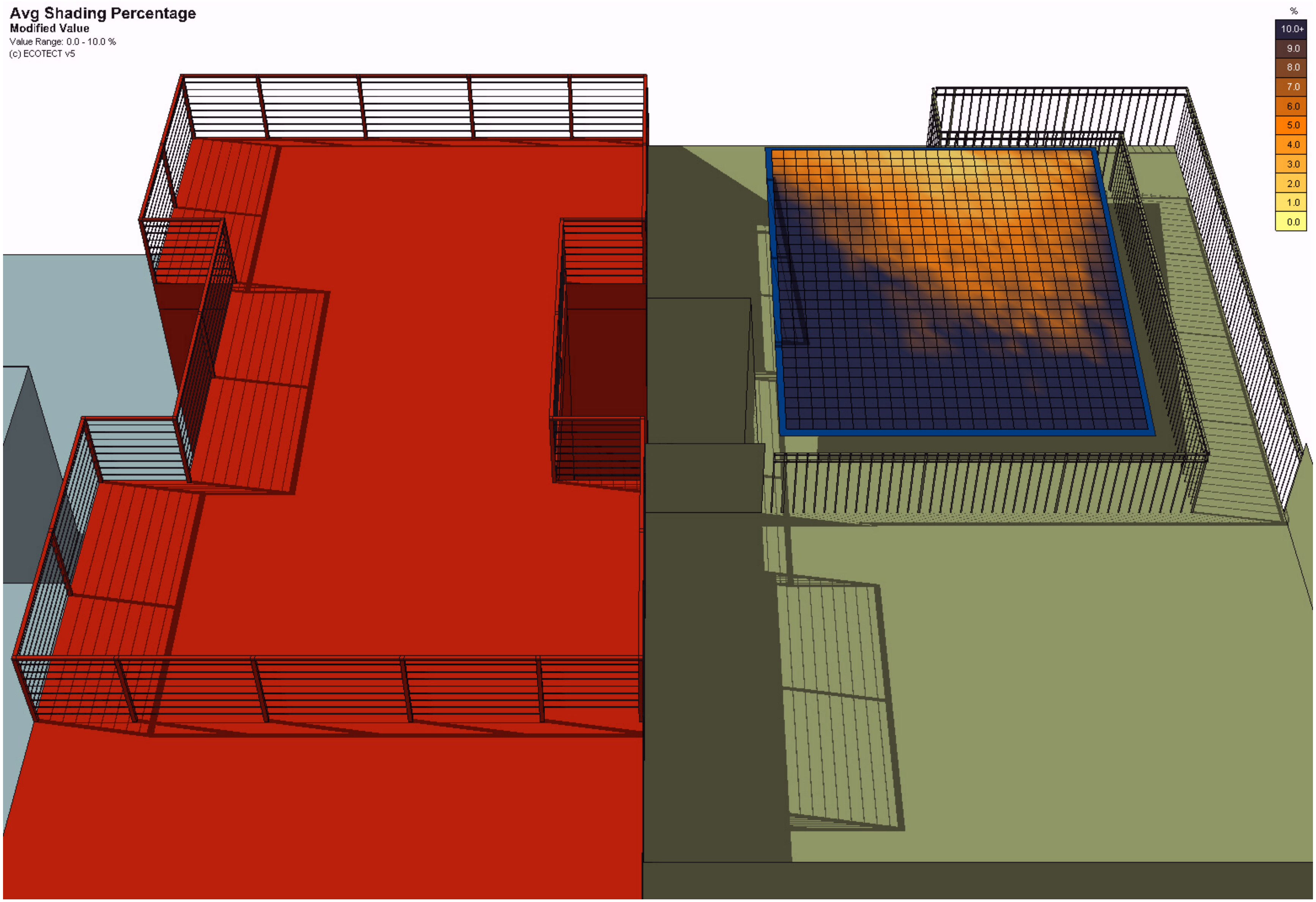
EXISTING / PROPOSED DIFFERENCE SOLAR ARRAY YEARLY AVERAGE OVERSHADOWING = +6.19%



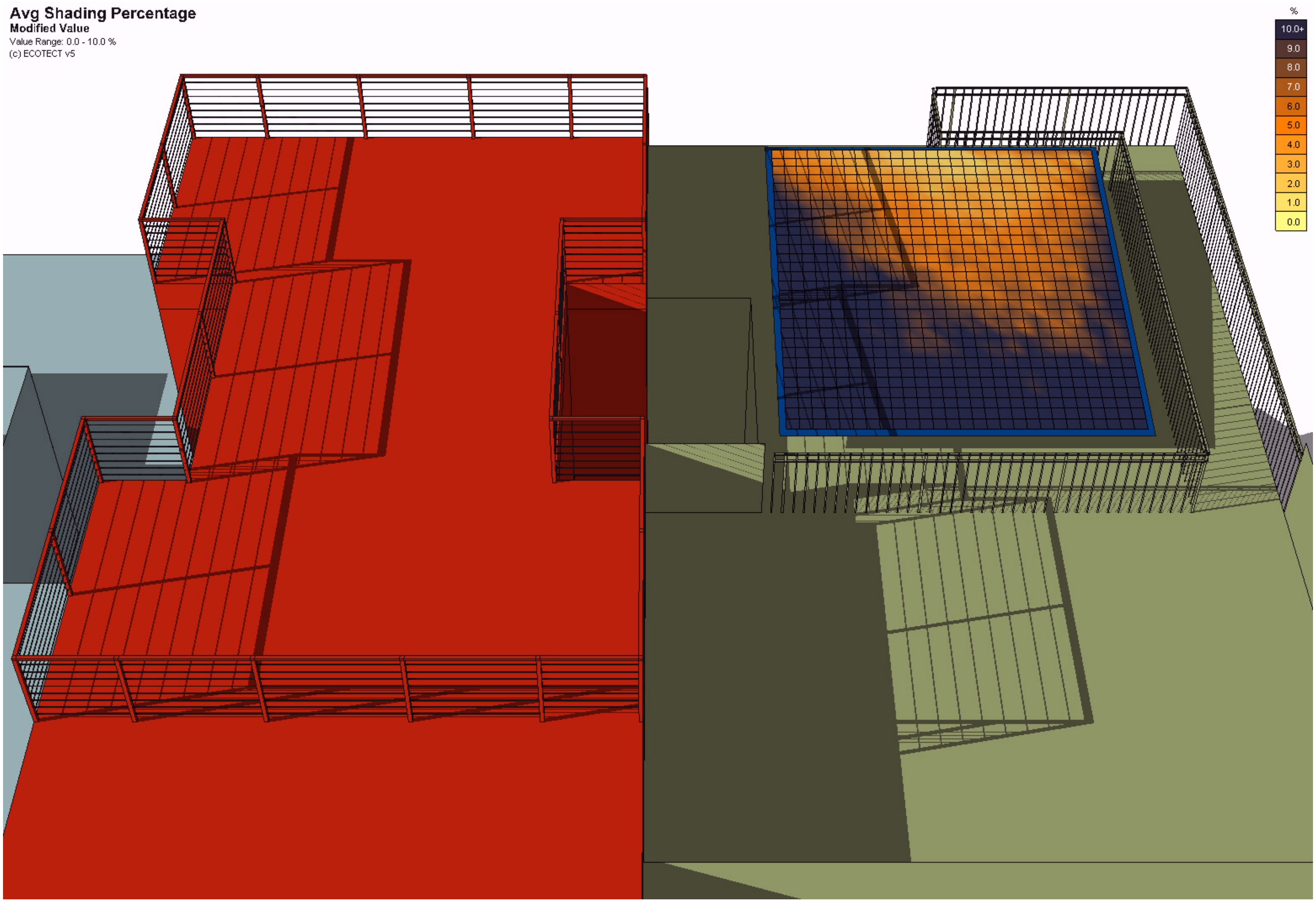
% DIFFERENCE INCREASE SOLAR ARRAY YEARLY AVERAGE OVERSHADOWING = +694.42%



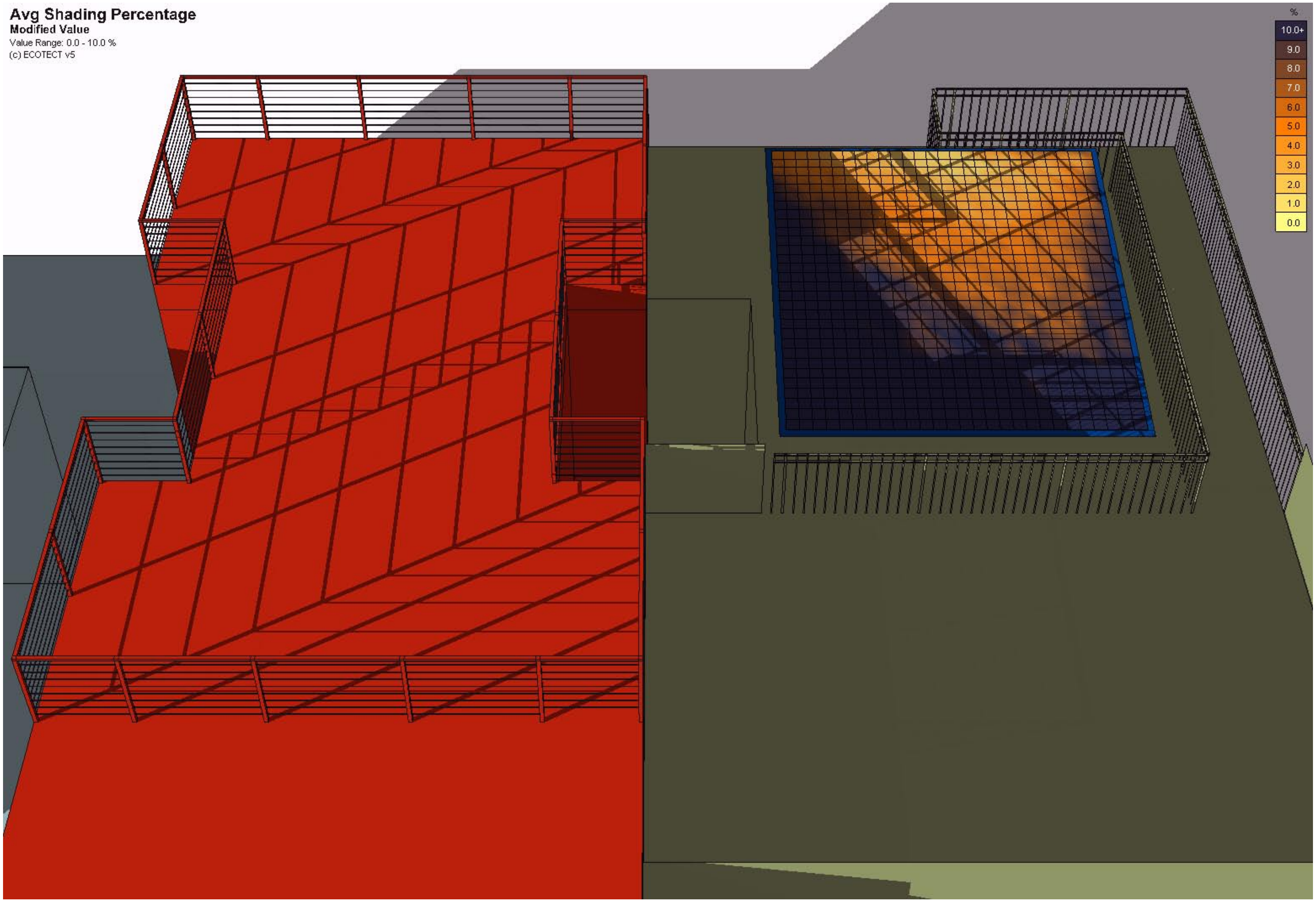
PROPOSED CONDITIONS | JUNE 21ST 4:00 PM



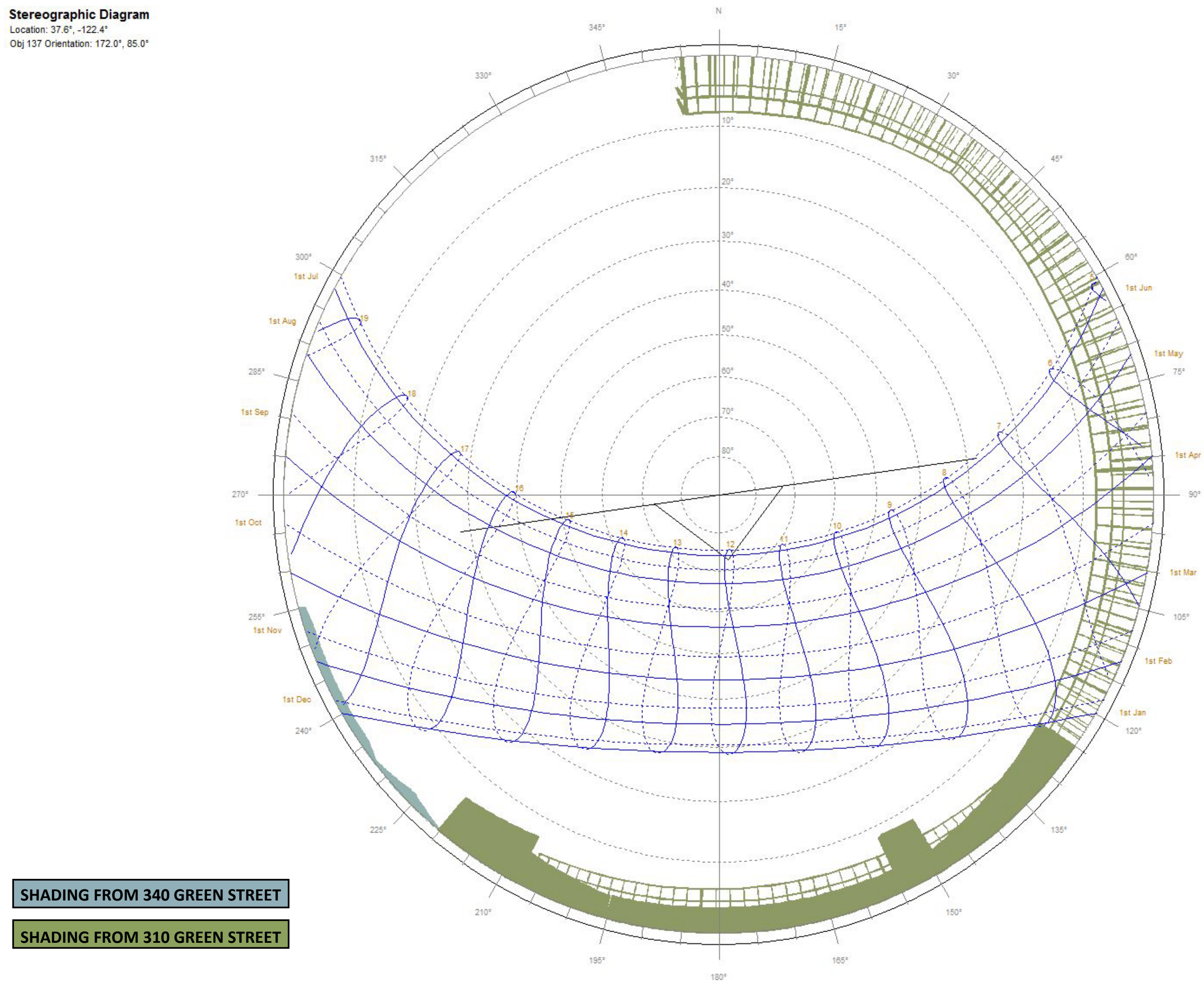
PROPOSED CONDITIONS | SEPTEMBER 21ST 4:00 PM



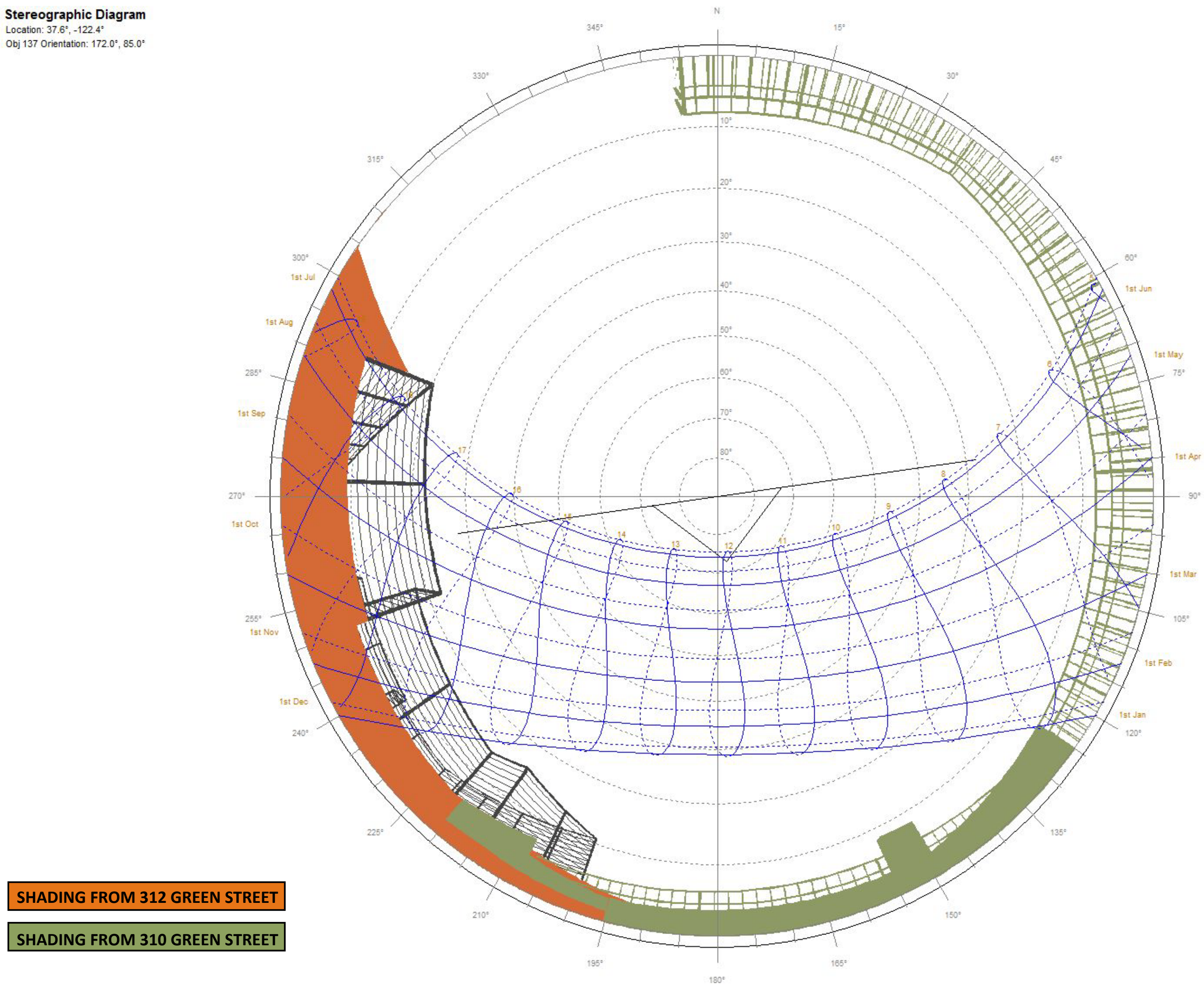
PROPOSED CONDITIONS | DECEMBER 21ST 4:00 PM



STEREOGRAPHIC SUNPATH DIAGRAM - EXISTING CONDITIONS



STEREOGRAPHIC SUNPATH DIAGRAM - PROPOSED CONDITIONS



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He has also been conducting training workshops throughout North America for the building performance analysis software Ecotect™ since 2006, while being an active forum user on the SQU1 Research support website from 2002 to 2008.

Prior to his designer and project manager position at DNM Architect in San Francisco, Olivier worked for Van der Ryn Architects in Sausalito, CA.
Olivier holds a B.S. in Environmental Science from Humboldt State University and a Master in Architecture from the University of Hawaii.
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Rooftops Solar Collection Potential [2002]
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Ecological Design Conference, Berkeley, CA. [July 2002]
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"**Prefab Prototypes"**
Mark and Peter Anderson, 2007, pp 170-171

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Electric Power Research Institute, Palo Alto, CA. 2004.

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Interfaced via Ecotect; basic knowledge [4 years]

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California's Solar Rights Act

A Review of the Statutes and Relevant Cases

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ENERGY POLICY INITIATIVES CENTER
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About EPIC

The Energy Policy Initiatives Center (EPIC) is a nonprofit academic and research center of the USD School of Law that studies energy policy issues affecting the San Diego region and California. EPIC integrates research and analysis, law school study, and public education, and serves as a source of legal and policy expertise and information in the development of sustainable solutions that meet our future energy needs.

For more information, please visit the EPIC website at www.sandiego.edu/epic.

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1. INTRODUCTION

California has been a leader in promoting solar energy since 1976, when it began to provide financial incentives for investment in solar energy technologies.[1] One legacy of California's early interest in solar energy is a series of laws designed to protect a consumer's right to install and operate solar energy technology on a home or business, including access to sunlight, or solar access. Although California's solar energy laws have been around for nearly thirty years, we now examine this groundbreaking legislation for two reasons. First, consumers and businesses often misunderstand the provisions and application of these laws. Second, given the significant financial incentives available for solar technologies in California and the availability of property-assessed clean energy ("PACE") financing programs,[2] it is likely that the number of operating solar energy systems will increase dramatically. As a result, it is reasonable to expect that the number of solar access questions in California will also increase.

This paper examines the sections of California law known collectively as the Solar Rights Act (hereinafter "the Act"), and reviews lawsuits brought under the Act.[3] Through the Act, which was enacted in 1978, the legislature sought to balance the needs of individual solar energy system owners with other property owners by developing solar access rights.[4] The Act limits the ability of covenants, conditions, and restrictions, (hereinafter "CC&Rs") typically enforced by homeowner associations (hereinafter "HOAs"), and local governments to restrict solar installations. These are perhaps the most well known and frequently contested provisions of the Act.[5] However, the Act also creates the legal right to a solar easement and requires local governments to preserve passive cooling and heating opportunities to the extent feasible in new development projects. The extent to which the Act protects solar energy system owners from restrictions by HOAs and local governments is frequently misunderstood and the subject of many disputes. Therefore, this paper is intended to provide solar energy users, HOAs, and local governments more information about the content and application of California's primary solar access law.

1.1. Organization of the Paper

The paper is organized into the following sections:

- Section 2 provides a brief overview of the Act's key provisions.
- Section 3 discusses the ability of CC&Rs, such as those enforced by HOAs, to restrict solar energy installations.

---

[1] A solar energy tax credit was created in 1976 and codified in California Revenue and Taxation Code Section 23601

[2] PACE programs allow local government entities to offer sustainable energy project loans to eligible property owners. Through the creation of financing districts, property owners can finance renewable onsite generation installations and energy efficiency improvements through a voluntary assessment on their property tax bills.

[3] The Solar Rights Act comprises the following California codes of law: California Civil Code Sections 714 and 714.1, California Civil Code Section 801, California Civil Code Section 801.5, California Government Code Section 65850.5, California Health and Safety Code Section 17959.1, California Government Code Section 66475.3, and California Government Code Section 66473.1.

[4] *See* 1978 Cal. Stat. ch. 1154.

[5] While not all common interest developments associations are called HOAs, for simplicity we use HOA throughout this paper to denote all associations.

- Section 4 discusses how provisions of the Act limit the ability of local governments to restrict solar energy installations.
- Section 5 provides information about the definition and use of solar easements, which are provided for in the Act.
- In Section 6, we examine solar easements in new developments, as required and permitted by the Act.
- Section 7 summarizes and concludes this paper.
- The Appendix, comprising Sections 8 and 9, includes other resources discussing the Act and the full text of the statutory codes comprising the Act.

2. OVERVIEW OF THE ACT

The Act creates a legal framework for solar access. It includes limited protections to allow consumers access to sunlight and to limit the ability of HOAs and local governments from preventing the installation of solar energy systems.

The Act was adopted in 1978 and went into effect on January 1, 1979.[6] Its enactment contributed to California's strong policy commitment to solar energy. According to the original legislation, "[t]he purpose of the act is to promote and encourage the widespread use of solar energy systems and to protect and facilitate adequate access to the sunlight which is necessary to operate solar energy systems."[7] The enacting bill further states that:

The use of solar energy systems will reduce the state's dependence on nonrenewable fossil fuels, supplement existing energy sources, and decrease the air and water pollution which results from the use of conventional energy sources. It is, therefore, the policy of the state to encourage the use of solar energy systems.[8]

This policy rationale is as relevant today as it was in 1978 and continues to drive California's solar energy policy initiatives.

2.1. Components of the Act

For the purposes of this paper, we focus on the following six key provisions of the Act in California law today:

1. Limits on CC&Rs to Restrict Solar Installations – The Act prohibits CC&Rs, like those enforced by HOAs, which would unreasonably restrict the use or installation of solar energy systems. (California Civil Code Sections 714 and 714.1).

2. Solar Easements – The Act establishes the legal right to a solar easement, which protects access to sunlight across adjacent properties. (California Civil Code Section 801). It also describes the minimum requirements needed to create a solar easement. (California Civil Code Section 801.5).

3. Definition of a Solar Energy System – The Act defines which solar energy systems are covered by its provisions. (California Civil Code Section 801.5).

4. Limits to Local Government Restrictions on Solar Installations – The Act discourages local governments from adopting an ordinance that would unreasonably restrict the use of solar energy systems. (California Government Code Section 65850.5). It also requires local governments to use a non-discretionary permitting process for solar energy systems. (California Government Code Section 65850.5 and California Health and Safety Code Section 17959.1). Additionally, provisions of the Act require local governments seeking state-sponsored incentives for solar energy systems to demonstrate compliance with certain provisions of the Act. (California Civil Code Section 714).

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[6] 1978 Cal. Stat. ch. 1154.

[7] *Id.* at Sec. 2(c).

[8] *Id.* at Sec. 2(b).

5. Passive Solar Opportunities in Subdivisions – The Act requires certain subdivisions to provide for future passive and natural heating and cooling opportunities to the extent feasible. (California Government Code Section 66473.1).

6. Allowance for Requiring Solar Easements – The Act allows cities and counties to require by ordinance the dedication of solar easements in certain subdivision developments as a condition of tentative map approval. (California Government Code Section 66475.3).

3. LIMITS ON CC&RS TO RESTRICT SOLAR INSTALLATIONS

In California, common interest developments such as condominiums and planned communities typically have associations to manage their affairs and enforce their rules. These associations, often called HOAs, are widespread and an increasingly important part of homeownership in California.[9] HOAs have rules and regulations, expressed in part through CC&Rs that govern many aspects of homeownership within the common interest development, including the installation of solar energy systems. To ensure that CC&Rs do not place unreasonable restrictions on the use of solar energy, California enacted Civil Code Section 714 in 1978 as part of the Act.[10] Section 714 limits the ability of HOAs to restrict solar energy system installations through unreasonable CC&Rs and prohibits undue discrimination in processes used to consider and approve solar energy installations.

3.1. What are CC&Rs?

CC&Rs are the governing documents that dictate how an HOA operates and what rules the owners, their tenants, and guests must obey. CC&Rs include three distinct legal mechanisms: (1) covenants; (2) conditions; and (3) restrictions. Covenants, also called "restrictive covenants," are enforceable promises that assign either a benefit or a burden to a property.[11] Covenants are usually part of the property title or deed and therefore apply to subsequent property owners. Conditions relate to the circumstances that may end an ownership interest (e.g., right of first refusal, dissolution of the subdivision).[12] Restrictions refer to legal restrictions placed on the ownership or use of the property, such as easements or liens.[13] In common interest developments, restrictive covenants typically dictate the manner in which solar energy systems can be installed.[14]

3.2. Does the Act Prohibit All CC&Rs From Restricting Solar Installations?

The Act contains many provisions and broadly addresses solar access issues, but it is perhaps best known for prohibiting CC&Rs that unreasonably restrict solar energy system installations. California Civil Code Section 714(a), in pertinent part, provides that "[a]ny covenant, restriction, or condition contained in any deed, contract, security instrument, or other instrument affecting the transfer or sale of, or any interest in, real property . . . that effectively prohibits or restricts the installation or use of a solar energy system is void and unenforceable."[15] Because Section 714 does not define the precise meaning and application of "effectively

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[9] Julia L. Johnston & Kimberly Johnston-Dodds, *California Research Bureau, Common Interest Developments: Housing at Risk?* 1 (2002), *available at* http://www.library.ca.gov/crb/02/12/02-012.pdf.

[10] *See* 1978 Cal. Stat. ch. 1154.

[11] *Black's Law Dictionary* 419 (9th ed. 2009).

[12] See id.

[13] *Id.* at 421.

[14] Thomas Starrs et al., *Bringing Solar Energy to the Planned Community: A Handbook on Rooftop Solar Systems and Private Land Use Restrictions* 13, http://www.sdenergy.org/uploads/Final_CC&R_Handbook_1-01.pdf.

[15] While Section 714(a) does not explicitly state that this prohibition applies to leases, a cautious reading of the Act suggests that this prohibition covers residential, commercial, and industrial leases.

prohibits or restricts," courts have adopted a practical, flexible standard that permits the many variations of restrictions and effects to be considered on a case-by-case basis.[16]

Although the intent of Section 714(a) is to prohibit CC&Rs from placing restrictions on solar energy system installation, other subsections of 714 and 714.1 allow CC&Rs to impose certain reasonable restrictions on solar installations.[17] The following provides information to determine whether a restriction is considered reasonable under the Act.

3.2.1. Cost and Performance Criteria for Reasonable Restrictions

The Act permits CC&Rs to impose requirements that do not "significantly" increase the cost of the system or decrease its efficiency or performance.[18] Sections 714(d)(1)(A) and 714(d)(1)(B) provide criteria to define when a restriction has "significantly" altered system price or performance for both solar water heating and photovoltaic systems. Restrictions cannot increase the cost of solar water heating systems by more than twenty percent or decrease the system's efficiency by more than twenty percent.[19] Restrictions on photovoltaic systems cannot increase the system cost by more than $2,000 or decrease system efficiency by more than twenty percent.[20] Restrictions on either type of system need only increase cost or decrease efficiency to be found unreasonable under the Act.[21]

With limited case law in this area, it is unclear whether these criteria could also be applied to restrictions imposed by local governments (e.g., restrictions or requirements imposed during the permitting process). We discuss local governments' ability to restrict solar energy systems in Section 4 of this paper.

3.2.2. Alternative Comparable System

Section 714(b) also permits reasonable restrictions that allow a prospective solar energy system owner to install "an alternative system of comparable cost, efficiency, and energy conservation benefits." Although Section 714(b) does not explain what makes an alternative system "comparable," a California Court of Appeal found that an HOA could prohibit installation of passive solar water heaters, which can extend above the roof surface, but allow comparable active solar water heaters, which can have a lower profile on the roof and are similar in cost and performance.[22]

3.2.3. Other Restrictions Permitted Under the Act

Section 714.1 permits CC&Rs to impose certain restrictions on solar energy system installations despite the cost, efficiency, and comparable system criteria provided for in Section 714. Separate from the reasonable

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[16] *See* Palos Verdes Homes Ass'n v. Rodman, 182 Cal. App. 3d 324, 328 (1986).

[17] *See* Cal. Civ. Code §§ 714(b), 714(d)(1)(A), and 714(d)(1)(B).

[18] § 714(b).

[19] § 714(d)(1)(A).

[20] § 714(d)(1)(B).

[21] *See* § 714(d)(1)(A)-(B).

[22] *See* Palos Verdes Ass'n v. Rodman, 182 Cal. App. 3d 324, 328 (1986).

restrictions permissible under Section 714, Section 714.1 allows CC&Rs to impose the following reasonable restrictions:

- Restrictions on Common Area Installations – Section 714.1(a) permits CC&Rs to "impose reasonable provisions" that restrict solar energy installations in common areas. Common areas are defined in Section 1351(b) as "the entire common interest development except the separate interests therein." That is, a common area is the area of the development not owned separately by individuals. For example, in a condominium or planned development, all the property other than units, homes, parcels, and lots owned by individuals would be considered common areas. These typically include community centers, walkways, or common hallways.
- Prior Approval – Section 714.1(b) requires "the owner of a separate interest, as defined in Section 1351, to obtain the approval of the association for the installation of a solar energy system in a separate interest owned by another." Section 1351(a) defines an "association" as "a nonprofit corporation or unincorporated association created for the purpose of managing a common interest development." This definition generally refers to HOAs. In the context of Section 714.1(b), a common interest development is a: (1) community apartment project; (2) condominium project; (3) planned development; or (4) a stock cooperative.23 In general, a property owner in a common interest development seeking to install a solar energy system should contact their HOA to determine installation policies and guidelines.
- Maintenance and Repair – Section 714.1(c) allows HOAs to create requirements relating to the maintenance, repair, or replacement of roofs or other building components affected by solar energy installations.
- Indemnification or Reimbursement – Section 714.1(d) allows associations to require solar energy system installers to reimburse the association for loss or damage caused by installation, maintenance, or use of the solar energy system.

3.3. Definition of a Solar Energy System

The Act defines what types of solar energy systems qualify for its legal protections. For the purposes of the Act, Section 801.5(a) defines a "solar energy system" as any solar collector or other solar energy device or any structural design feature of a building whose primary purpose is to provide for the collection, storage, and distribution of solar energy for space heating, space cooling, electric generation, or water heating.[24] It is important to note that Section 801.5(a)'s statutory definition of "solar energy system" does not explicitly state whether it includes only small-scale consumer systems or whether it also encompasses large-scale industrial solar systems.[25]

[23] Each of these common interest development types is defined in California Civil Code Section 1351(c).

[24] The Act's definition of a solar energy system differs from the statutory definition of a "solar collector" promulgated in California's Solar Shade Control Act under California Public Resources Code Section 25981.

[25] However, an examination of the legislative history behind a recent amendment to the Act arguably suggests that Section 801.5(a)'s definition of a solar energy system is intended to apply only to consumer distributed generation systems. In a 2000 bill which revised Section 801.5(a)'s definition of "solar energy system," the Legislature declared that "low polluting disturbed generation resources, installed on customer sites, can reduce customer costs of energy . . . and provide customers with improved reliability in the event of an electricity outage." 2000 Cal. Stat. ch. 537, sec. 801.5, § 1(b). Furthermore, the same bill defined "distributed generation" as "any onsite generation, interconnected and operating in parallel with the electricity grid, that is used *solely* to meet onsite electric load." *Id.* at sec. 25620.10, § 4(i)(3)

Based on this statutory definition, the following common solar energy systems would likely be considered "solar energy systems" under the Act:

- Photovoltaics (solar electric).
- Solar water heating for use within a building.
- Solar water heating for space heating.
- Solar pool heating.

3.3.1. Additional Criteria to Supplement the Definition of a Solar Energy System

Section 714(c)(1) provides additional criteria that supplements the definition of a solar energy system. These criteria likely would have to be met in addition to the standard definition provided in Section 801.5 in order to be considered an eligible solar energy system under Section 714.

- Health and Safety Requirements – Section 714(c)(1) provides that a solar energy system must meet applicable health and safety standards and requirements imposed by state and local permitting authorities.
- Solar Water Heating Certification – Section 714(c)(2) requires a solar energy system used to heat water to be certified by the Solar Rating Certification Corporation (hereinafter "SRCC"), a nonprofit third party organization, or other nationally recognized certification agencies.[26] This section specifies that the entire solar energy system and installation process must receive certification, rather than simply certifying each of its component parts.
- Solar Electric Standards – Section 714(c)(3) requires a solar energy system used to produce electricity, such as photovoltaics, to meet all applicable safety and performance standards established by the National Electrical Code, the Institute of Electrical and Electronics Engineers, and accredited testing laboratories such as Underwriters Laboratories and, where applicable, rules of the California Public Utilities Commission regarding safety and reliability.

3.4. Fair Approval Process for Solar Energy Systems

The Act additionally seeks to ensure that processes used to consider and approve solar energy system installations are fair to the applicant. Section 714(e)(1) provides that:

Whenever approval is required for the installation or use of a solar energy system, the application for approval shall be processed and approved by the appropriate approving entity in the same manner as an application for approval of an architectural modification to the property, and shall not be willfully avoided or delayed.

This subsection uses broad language that arguably could apply to the approval processes of an HOA or a local government. Given the context of subsections in Section 714 and existing case law, this language on fair approval processes most likely applies to HOAs. It is unclear whether it also applies to approval processes of

(emphasis added). Therefore, this legislative history presents one plausible interpretation suggesting that only small-scale consumer systems intended to meet onsite electric load qualify as solar energy systems under the Act.

[26] SRCC is a nonprofit third party supported by the United States Department of Energy. SRCC can be found online at www.solar-rating.org.

local governments because California Government Code Section 65850.5 specifically addresses city and county permitting of solar energy systems. We discuss this topic in more detail in Section 4.

3.5. Violation of California Civil Code Section 714

California Civil Code Section 714(f) describes the penalties for violation of this section of the Act. It states that "[a]ny entity, other than a public entity, that willfully violates this section shall be liable to the applicant or other party for actual damages occasioned thereby, and shall pay a civil penalty to the applicant or other party in an amount not to exceed one thousand dollars ($1,000)." In addition, Section 714(g) provides that reasonable attorney's fee will be awarded to the prevailing party in a case brought to enforce compliance with Section 714.

3.6. Relevant Cases

Published case law relating to the Act is limited. This is particularly true for published cases relating to HOAs imposing unreasonable restrictions on solar energy systems installations. Lack of awareness on the part of homeowners and HOAs about the Act's provisions and potentially high litigation costs could account for the limited case law.[27]

This section provides a summary of the following cases involving HOAs and individual solar energy system owners.

- Tesoro Del Valle Master Homeowners Ass'n. v. Griffin, 133 Cal. Rptr. 3d 167 (2011).
- Palos Verdes Home Ass'n v. Rodman, 182 Cal. App. 3d 324 (1986).
- Fox Creek Cmty. Ass'n v. Carson, 1 CA-CV 11-0676, 2012 WL 2793206 (Ariz. Ct. App. July 10, 2012).
- Garden Lakes Community Ass'n v. Madigan, 204 Ariz. 238 (Ct. App. 2003).

3.6.1. Tesoro Del Valle Master Homeowners Ass'n. v. Griffin

Tesoro Del Valle Master Homeowners Association v. Griffin addressed the issues of whether the CC&Rs imposed a reasonable restriction on solar energy systems and whether an HOA can deny permission to build a solar energy system without identifying an alternative location that is "reasonable" under the Solar Rights Act.[28]

Griffin, a resident of the Tesoro housing development, applied to install a photovoltaic rack system on the slope outside his home's perimeter wall and on the roof of the home.[29] The Tesoro CC&Rs generally allowed construction of solar energy systems; however, Tesoro Board approval was required for all solar installations and improvements on sloped areas could not damage the existing slope ratio, drainage, or cause erosion.[30]

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[27] Valerie J. Faden, Net Metering of Renewable Energy: How Traditional Electricity Suppliers Fight to Keep You in the Dark, 10 Widener J. Pub. L. 109, 131 (2000).

[28] *Tesoro Del Valle Master Homeowners Assn. v. Griffin*, 133 Cal. Rptr. 3d 167 (2011). See id. at 174-75, 184.

[29] *Id.* at 171; Brief of Appellant at 1, *Tesoro Del Valle Master Homeowners Assn.,* 133 Cal. Rptr. 3d 167 (2011) (No. B222531), 2010 WL 6380566 at *1.

[30] *Id.* at 170-71.

The Tesoro Board denied Griffin's application to construct the hillside photovoltaic system due to safety and aesthetic concerns, but Griffin proceeded to construct the photovoltaic system without approval.[31] The Board filed suit to have the hillside photovoltaic system removed and the jury found the Tesoro CC&R restrictions "reasonable" under section 714(b).[32]

On appeal, the court held that whether Tesoro's CC&Rs constitute a "reasonable" restriction is a question of fact for the jury.[33] The court found substantial evidence supporting the jury's finding based on expert testimony showing that a comparable alternative system could be installed within Griffin's yard for a lower cost and with only a 14 percent reduction in output.[34] Finally, the court stated that the Tesoro Board was not responsible for identifying an alternative site for building the photovoltaic system upon denial of Griffin's application to build on the hillside.[35] Therefore, the court ordered Griffin to remove the hillside solar energy system.[36]

3.6.2. Palos Verdes Home Ass'n v. Rodman

Palos Verdes Home Ass'n v. Rodman provides guidance on what constitutes a reasonable restriction on solar energy system installations.[37] The issue in this case was whether the HOA's actions violated Section 714's reasonable restriction standard.[38]

Rodman, a resident of the Palos Verdes Home Association, sought to install a passive solar water heating system on the roof of his home.[39] The Palos Verdes Home Association's CC&Rs required a homeowner to receive prior approval from the HOA for any improvements made outside of a home.[40] The CC&Rs also contained guidelines for installing a solar energy system.[41] The CC&Rs generally allowed for the installation of active systems, but prohibited Rodman's proposed passive system.[42] The prohibition of Rodman's proposed system was based primarily on aesthetics.[43] If Rodman's passive system was designed to comply with the HOA's CC&Rs, the additional modifications would have added between $1,400 and $1,800 to the cost of installation.[44]

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[31] *Id.* at 172, 179.

[32] *Id.* at 178.

[33] *Id.* at 176.

[34] *Id.* at 178.

[35] *Id.* at 178-79, 184.

[36] *Id.* at 185.

[37] 182 Cal. App. 3d 324, 328–29 (1986).

[38] *Id.* at 328.

[39] *Id.* at 326.

[40] Id.

[41] *Id.* at 327, note 2.

[42] *Id.* at 328.

[43] Id.

[44] Id.

Rodman ignored the CC&Rs and had the system installed by a private company.[45] The HOA notified Rodman that his system was not in compliance with their guidelines and filed a complaint against Rodman.[46] The trial court ruled in favor of the HOA, requiring Rodman to remove his system.[47] Rodman appealed, arguing that the HOA's CC&Rs violated Section 714.[48] Rodman argued that the HOA's solar installation guidelines effectively restricted his passive solar energy system installation by significantly increasing the system's cost and decreasing its efficiency.[49]

The appellate court ultimately affirmed the trial court's decision, ruling that an installer of a solar energy system cannot ignore HOA guidelines when those guidelines would only minimally increase installation costs.[50] The court relied on expert testimony presented by the HOA.[51] This testimony, given by a mechanical engineer, concluded that the active systems allowed by the HOA were comparable in cost and performance to the prohibited passive systems.[52] The court reasoned that even though there would have been a significant increase in cost to install the passive system under HOA guidelines, Rodman could have installed an active system with no increase in cost.[53] As a result, the court concluded that the HOA's CC&Rs were reasonable and did not violate Section 714.[54]

3.6.3. Fox Creek Cmty. Ass'n v. Carson

Fox Creek Community Association v. Carson, an unreported Arizona case, addressed the issue of what constitutes a reasonable restriction on solar installations.[55] Like *Garden Lakes Community Association*, discussed above, California courts are not required to abide by the holding of *Fox Creek* because the decision was made in Arizona. This case discusses Arizona's solar rights law and is included as reference only.

Carson owned a home in Fox Creek Estates, which had CC&Rs requiring homeowners to acquire the Association's approval before building a solar energy system.[56] The CC&Rs required solar devices be screened or concealed to the extent the Association reasonably deems appropriate.[57]

Carson submitted an application to install a solar tracking device outside the wall surrounding his home and proposed screening the device with Rosewood Sisso trees.[58] Carson began construction of the solar tracking

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[45] *Id.* at 326.

[46] *Id.* at 326–27.

[47] *Id.* at 327.

[48] Id.

[49] Id.

[50] *Id.* at 328.

[51] Id.

[52] Id.

[53] Id.

[54] *Id.* at 328–29.

[55] *Fox Creek Cmty. Ass'n v. Carson*, 1 CA-CV 11-0676, 2012 WL 2793206, ¶ 8 (Ariz. Ct. App. July 10, 2012).

[56] *Id.* at ¶ 2.

[57] Id.

device before receiving the Association's approval.[59] The Association denied Carson's application, but agreed the solar installation would be approved if a six-foot block wall was constructed around the device or it was moved inside the fenced backyard.[60]

Carson did not construct the wall or move the solar tracker and the Association filed suit.[61] Carson submitted evidence that construction of the wall would cost between $12,800 and $15,200.[62] Despite the cost, the court held that the Association's restrictions did not prohibit installation of Carson's solar device because it could have been installed in the fenced yard for a lower cost and with only a marginally lower level of energy output.[63] Alternatively, a block wall could be built to screen the device.[64] Therefore, the court held that Carson's solar tracking device must either be moved to the backyard or screened with a brick wall.[65]

3.6.4. Garden Lakes Community Ass'n v. Madigan

Garden Lakes Community Ass'n v. Madigan, an Arizona case, also seeks to define what can be considered a reasonable restriction on solar installations.[66] In this case, the court ruled that the increased cost required to comply with the HOA's CC&Rs was one factor that effectively prohibited the installation of solar energy systems.[67] Because this decision was made in an Arizona court, California courts are not required to abide by its holding. In addition, the decision deals with Arizona's solar rights law, which uses different language than California law. We include it here only as a reference.

The Garden Lakes Community Association sued the Madigan family and the Speak family for installing solar panels that were not approved by the HOA and did not meet the HOA's installation requirements.[68] Under the HOA's CC&Rs, panels cannot be visible to the public and must be screened.[69] In this instance, both the Madigans and the Speaks installed solar panels on their roof without a screen.[70] In order to comply with the CC&Rs, the Speaks would have had to either construct a patio cover and place the solar panels on top of the patio roof or build a screening wall around the existing roof panels.[71] The HOA's construction expert testified that the cost of building a patio cover for the Speaks would have been nearly $5,000; not including

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[58] *Id.* at ¶ 4-5.

[59] *Id.* at ¶ 4-6.

[60] *Id.* at ¶ 5-6.

[61] *Id.* at ¶ 5.

[62] *Id.* at ¶ 17.

[63] *Id.* at ¶ 15-16.

[64] Id.

[65] *Id.* at ¶ 7.

[66] 204 Ariz. 238 (Ct. App. 2003).

[67] *Id.* at 243.

[68] *Id.* at 240.

[69] *Id.* at 239.

[70] Id.

[71] *Id.* at 242.

the additional cost incurred installing the solar panels on the patio roof.[72] Both the trial court and appellate court ruled in favor of the homeowners.[73] Relying on Arizona's solar rights law, the appellate court found that the HOA's CC&Rs "effectively prohibited" the installation and use of the solar panels.[74] Concluding that "cost is a factor to be considered" in determining whether a CC&R effectively prohibits solar energy systems, the court held that, among other factors, the additional costs necessary to comply with the HOA's CC&Rs were enough to effectively dissuade homeowners from installing solar energy systems.[75]

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[72] *Id.* at 243.

[73] Id.

[74] Id.

[75] Id.

4. LOCAL GOVERNMENT'S ABILITY TO RESTRICT SOLAR INSTALLATIONS

In this section, we discuss how California Government Code Section 65850.5 and California Civil Code Section 714(h) limit the ability of local governments to restrict solar energy systems by requiring the use of a non-discretionary permitting process and by requiring local governments to certify compliance with Section 714 prior to receiving state-sponsored solar energy incentives.[76]

4.1. Non-Discretionary Permitting of Solar Energy Systems

California Government Code Section 65850.5 establishes permitting standards and requires local governments to use a non-discretionary permitting process, rather than a discretionary permitting process, to review solar energy system applications. However, as discussed in Section 4.1.5, the Act is ambiguous as to which type of solar energy system falls under the Act's non-discretionary permitting process. This portion of the Act includes the following provisions.

4.1.1. Solar as a Statewide Affair

Section 65850.5(a), in part, provides that "[t]he implementation of consistent statewide standards to achieve the timely and cost-effective installation of solar energy systems is not a municipal affair . . . but is instead a matter of statewide concern." This statement provides a basis to establish a statewide standard for permitting and discourage local governments from enacting varying and subjective permitting standards.[77]

4.1.2. Legislative Intent Language

Section 65850.5(a) expresses California's intent to promote and encourage solar energy systems. It also promulgates the legislature's intent to prohibit local governments from implementing burdensome permitting requirements and encourages public agencies to remove any barriers to solar energy installations.[78] While codified, this legislative intent language does not *expressly* prohibit any actions by local governments. Rather, it only discourages certain actions, and therefore, it is unclear how such language would be enforced by the courts. Section 65850.5 includes the following policy statements:

- Discourage Local Governments from Placing Barriers on Solar installations – Section 65850.5(a), in pertinent part, states that it is the intent of the legislature to prohibit local governments from adopting "ordinances that create unreasonable barriers to the installation of solar energy systems, including but not limited to, design review for aesthetic purposes." This subsection seeks to prevent a local jurisdiction from restricting a solar installation based solely on discretionary factors such as aesthetics, but stops short

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[76] Two bills added provisions to the Act that expand its reach to local governments: AB 1407, which was enacted in 2003 and codified at 2003 Cal. Stat. ch. 290, and SB 2473, which was enacted in 2004 and codified at 2004 Cal. Stat. ch. 789.

[77] This statement might also have been included to require charter cities to comply with the provisions of this section of law. *See Energy; Incentives for the Use of Solar Energy*, 10 Pac L.J. 478, 481 (1979).

[78] Cal. Gov't Code § 65850.5(a).

of expressly prohibiting such restrictions. Because the language is expressed as legislative intent, it is unclear how a court might enforce this section of law.[79]

- California Policy to Promote Solar Energy – Section 65850.5(a) provides that it is the policy of the state of California to "promote and encourage the use of solar energy systems and to limit obstacles to their use."
- Encourage Local Governments to Remove Barriers to Solar Energy – Section 65850.5(a) promulgates that it is the intent of the legislature that "local agencies comply not only with the language of this section, but also the legislative intent to encourage the installation of solar energy system by removing obstacles to, and minimizing costs of, permitting for such systems."

4.1.3. Permitting Standards

Section 65850.5(b) and the remaining subsections of Section 65850.5 establish permitting standards for solar energy systems based on health and safety concerns and equipment certification and performance standards. The Act requires cities and counties to "administratively" approve applications to install solar energy systems by issuing a building permit or other non-discretionary permit.[80] Based on this section of law, local governments cannot implement or use a discretionary permitting process to review solar energy applications. Instead, they must use a non-discretionary ministerial or administrative process that is based on the following criteria:

- Health and Safety – Local review of solar energy applications must be limited to "those standards and regulations necessary to ensure that the solar energy system will not have a specific, adverse impact upon the public health or safety."[81] The law defines a "specific adverse impact" as "a significant, quantifiable, direct, and unavoidable impact, based on objective, identified, and written public health or safety standards, policies, or conditions as they existed on the date the application was deemed complete."[82] To determine if an adverse impact exists, permitting officials must limit their review to local, state, and federal laws.[83]
- Solar Water Heater Certification – Section 65850.5(f)(2) provides that a solar water heating system must be certified by the SRCC or other nationally recognized certification agency. Certification must apply to the entire solar energy system and installation process.[84]
- Photovoltaics Compliance with Applicable Codes – As promulgated in Section 65850.5(f)(3), a photovoltaics or solar electric system must "meet all applicable safety and performance standards established by the National Electrical Code, the Institute of Electrical and Electronics Engineers, and

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[79] One interpretation is that this language does prevent cities and counties from enforcing ordinances that effectively prohibit or unreasonably restrict the use of solar energy systems other than for preservation or protection of public health and safety. This interpretation also presumes the statutory definition of unreasonable restrictions in California Civil Code Section 714 that applies to CC&Rs would also apply here to restrictions imposed by local governments. *See Energy; Incentives for the Use of Solar Energy*, 10 Pac L.J. at 481.

[80] Cal. Gov't Code § 65850.5(b).

[81] Id.

[82] § 65850.5(g)(3).

[83] § 65850.5(b).

[84] § 65850.5(f)(2).

accredited testing laboratories such as Underwriters Laboratories and, where applicable, rules of the Public Utilities Commission regarding safety and reliability."

4.1.4. Adverse Impact on Health or Safety

If a city or county finds that installing a solar energy system would result in an adverse impact on public health or safety, it can require a use permit.[85] However, according to Section 65850.5(c), the municipality cannot deny an application for the use permit unless it "makes written findings based upon substantial evidence in the record that the proposed installation would have a specific, adverse impact upon the public health or safety, and there is no feasible method to satisfactorily mitigate or avoid the specific, adverse impact." The Act defines "a feasible method to satisfactorily mitigate or avoid the specific, adverse impact" as including, but not limited to, "any cost-effective method, condition, or mitigation imposed by a city or county on another similarly situated application in a prior successful application for a permit."[86] The law also provides that a city or county shall use its best efforts to ensure that the selected method, condition, or mitigation also meets the cost and efficiency criteria of California Civil Code Section 714(d)(1)(A) and (B).[87] If the city or county places conditions on the application in order prevent the adverse impact on health and safety, those conditions must be at the lowest possible cost to the applicant.[88]

If the city or county denies the applicant an administrative (or ministerial) permit and/or a use permit, California Government Code Section 65850.5(d) authorizes the applicant to appeal the decision to the city or county planning commission.

4.1.5. Definition of a Solar Energy System

The term "solar energy system," as used in Section 65850.5, has the same meaning set forth in California Civil Code Section 801.5.[89] As discussed in Section 3.3 of this paper, Section 801.5's definition of "solar energy system" is silent as to whether it applies only to small-scale consumer systems or whether it also includes large-scale systems.[90] California Government Code Section 65850.5 also includes the same language

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[85] § 65850.5(b).

[86] § 65850.5(g)(1).

[87] Id.

[88] § 65850.5(e).

[89] § 65850.5(g)(2).

[90] California Civil Code Section 801.5(a), in pertinent part, states:

As used in this section, "solar energy system" means either of the following:

(1) Any solar collector or other solar energy device whose primary purpose is to provide for the collection, storage, and distribution of solar energy for space heating, space cooling, electric generation, or water heating.

(2) Any structural design feature of a building, whose primary purpose is to provide for the collection, storage, and distribution of solar energy for electricity generation, space heating or cooling, or for water heating.

contained in California Civil Code Section 714(c)(1) regarding health and safety codes and certifications for solar water heating and photovoltaics systems that supplements the standard definition. Therefore, proposed systems not meeting the Act's definition of a "solar energy system" are not protected by the Act's permitting process.

4.2. Local Government Compliance With Section 714

Section 714(h) prohibits a public entity from receiving state-sponsored grant funding or loans for solar energy programs if it fails to certify its compliance with the requirements of Section 714. The language in this subsection is somewhat ambiguous regarding which parts of Section 714 a public entity would have to comply with to be eligible for state-sponsored incentives. Only one other subsection, Section 714(f), specifically mentions local governments, and that subsection exempts public entities from paying damages.

A possible interpretation of this requirement is that public entities would have to comply with Section 714 by not imposing restrictions that significantly affect the cost and efficiency of a solar energy system (e.g., restrictions imposed through the permitting process). It is also possible that public agencies are considered "approving entities" and would also have to comply with the provisions in Section 714(e), which requires that a solar energy application be processed in the same manner used with similar applications and that the approving entity not willfully avoid or delay approval of the application. Section 714(h)(2) additionally prohibits local public entities from exempting residents in its jurisdiction from the requirements of Section 714. Therefore, a local government might also comply by demonstrating that it has not exempted any residents from the requirements of Section 714. In the absence of case law interpreting this specific subsection of the Act, it remains unclear which provisions of Section 714 a public entity would have to comply with to be eligible for state-sponsored solar energy incentives.

4.3. Relevant Cases

4.3.1. Larsen v. Town of Corte Madera

In the *Larsen v. Town of Corte Madera* line of cases, homeowner Larsen sought to use the provisions of California Government Code Section 65850.5 and California Health and Safety Code Section 17959.1 to overturn the Town of Corte Madera's denial of his petition to build a second story addition to his house, which he alleged would include a solar energy system.[91] Larsen repeatedly sought approval for his roof renovation through the Town's design review process, and the various applications had either been denied by the defendant Town or withdrawn by Larsen.[92]

This case was originally heard in 1996 in the U.S. District Court for the Northern District of California and was later reviewed on appeal by the Ninth Circuit Court of Appeals. Another case involving the same parties was argued before the U.S. District Court nine years later in 2005. In each case, Larsen attempted to use California laws intended to protect solar energy system owners from "unreasonable restrictions" to challenge local ordinances. Each case is summarized below.

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[91] *See* Larsen v. Town of Corte Madera (*Larsen I*), 1996 U.S. Dist. LEXIS 3936 (N.D. Cal. Mar. 26, 1996); Larsen v. Town of Corte Madera (*Larsen II*), 1996 U.S. App. LEXIS 33570 (9th Cir. Dec. 20, 1996); Larsen v. Town of Corte Madera (*Larsen III)*, 2005 U.S. Dist. LEXIS 30846 (N.D. Cal. Nov. 8, 2005).

[92] *Larsen III*, 2005 U.S. Dist. LEXIS at *1.

Larsen v. Town of Corte Madera (*Larsen I*), 1996 U.S. Dist. LEXIS 3936 (N.D. Cal. Mar. 26, 1996).

Larsen I is the original case brought by Larsen. In this action, Larsen was contesting the Town's land use decision rejecting Larsen's proposed construction.[93] In addition to Larsen's equal protection claim, at issue before the court was whether then-existing California Government Code Section 65850.5 and California Health and Safety Code Section 17959.1 required the Town to allow Larsen to make the requested modifications to his home to accommodate his planned solar energy system.[94] Prior to its amendment as of January 1, 2005, both California's Health and Safety Code and Government Code provisions were promulgated to prohibit local legislative bodies from enacting certain ordinances which would interfere with the installation of solar systems.[95] Specifically, the court was asked to determine whether these then-existing sections of law applied to "specific land use decisions made by a local government in its non-legislative capacities."[96]

Ruling in favor of the Town, the court held that both code sections were inapplicable to this case.[97] This was due, in large part, to the statutory language of the then-existing code sections. For instance, the court found that California Government Code Section 65850.5 was inapplicable here because that section "only applies to ordinances passed by local government legislative bodies." Because Larsen was contesting the specific land use decision of the Town in its non-legislative capacity, the court concluded that there was "no local ordinance at issue in this matter."[98] Therefore, the court rejected Larsen's argument and ruled in favor of the Town. In an unpublished decision, the Ninth Circuit Court of Appeals affirmed *Larsen I*.[99]

Larsen v. Town of Corte Madera (*Larsen III*), 2005 U.S. Dist. LEXIS 30846 (N.D. Cal. Nov. 8, 2005).

In this case, Larsen contested a Town resolution which increased the Town's design review fee from $45 to $785, plus $100 per hour for time and costs.[100] Larsen wished to raise the roof of his home an additional two feet so that he could install new solar panels, but objected to the Town's heightened design review fee.[101] In his complaint, Larsen alleged that the increase in the town's design review fee violated and was preempted by then-existing California Health and Safety Code Section 17959.1 and California Government Code Sections 65860 and 65850.5.[102]

The court ruled that Larsen's challenge to the Town's resolution failed on the merits for primarily two reasons.[103] First, the local resolution to raise the document review fee from $45 to $785 did not violate then-

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93 *Larsen I*, 2005 U.S. Dist. LEXIS at *1–*3.

94 *Id.* at *6.

95 *See* Cal. Gov't Code § 65850.5 (1979); Cal. Health & Safety Code § 17959.1 (1979).

96 *Larsen I*, 2005 U.S. Dist. LEXIS at *7.

97 *Id.* at *6.

98 *Id.* at *7–*8.

99 *Larsen II*, 1996 U.S. App. LEXIS at *2.

100 *Larsen III*, 2005 U.S. Dist. LEXIS 30846, at *3 (N.D. Cal. Nov. 8, 2005).

101 *Id.* at *1.

102 *Id.* at *3.

103 *Id.* at *14–*17.

existing Section 65860.5 because the resolution "simply increased the Town's design review fees" and did "not have the effect of prohibiting or of unreasonably restricting the use of solar energy systems."[104] Second, Larsen was not entitled to the legal protections offered by the Act because his building failed to meet the definition of a solar energy system, as defined in California Civil Code Section 801.5.[105] The court explained "that a roof, which is the focus of the design review process, is not part of a 'solar energy system.'"[106] Because the "primary purpose" of a roof is to cover a house, as opposed to the "collection, storage, and distribution of solar energy," Larsen's roof was not protected by the Act.[107]

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[104] *Id.* at *15 (internal quotations omitted).

[105] *Id.* at *16.

[106] Id.

[107] *Id.* at *17.

5. SOLAR EASEMENTS

An important factor when considering solar energy systems is current and future access to unobstructed sunlight. Shade from vegetation growth, increased building heights as a result of remodeling, and construction of new buildings on adjacent parcels can affect the amount of sunlight reaching a solar energy system in the future. California's Solar Shade Control Act provides limited protection to solar energy system owners from shading caused by trees and shrubs on adjacent properties.[108] No similar law exists to prevent new or modified structures on an adjacent property from shading an existing solar energy system. However, Sections 801 and 801.5 of the California Civil Code provide for solar easements, which allow a solar energy system owner access to sunlight across an adjacent parcel.

5.1. What is an Easement?

An easement is a right that allows the holder to make some use of land that is not theirs or prohibits the owner of another property from using their land in some way that infringes on the rights of another property owner.[109] There are two basic types of easements. An affirmative easement is a non-possessory right to use land in the possession of another.[110] A negative easement restricts a property owner from using their property in some manner.[111] A solar easement is generally considered a negative easement because it prevents a property owner from using their property in a manner that would prevent sunlight from reaching a solar energy system located on an adjacent property.

5.2. What is a Solar Easement?

Because a landowner's property rights extend to the airspace directly above their land, a landowner may grant access to the sunlight that transverses their land to a solar energy system owner on an adjacent parcel. This is generally referred to as a solar easement.[112] In 1978, as part of the Act, California added the right to receive sunlight to its list of statutorily recognized easements.[113] Section 801.5 defines a "solar easement" as the "right of receiving sunlight across real property of another for any solar energy system." A solar easement must therefore be created for the sole purpose of accessing sunlight to create thermal or electric energy using a solar energy system, as defined by Section 801.5. A person merely seeking to access sunlight could not seek protections under Sections 801 and 801.5.

5.3. Requirements to Establish a Solar Easement

Section 801.5 does not explicitly state that a solar easement must be created in writing, but one California court, in an unpublished portion of its opinion, held that a solar easement must be written to be

[108] Cal. Pub. Res. Code §§ 25980–25986.

[109] *Black's Law Dictionary* 585–86 (9th ed. 2009).

[110] *Id.* at 586.

[111] *Id.* at 587.

[112] *See* Melvin M. Eisenstadt & Albert E. Utton, *Solar Rights and Their Effect on Solar Heating and Cooling*, 16 Nat. Resources J. 363, 376 (1976).

[113] 1978 Cal. Stat. ch. 1154; *see also* Cal. Civ. Code § 801.

enforceable.[114] Section 801.5(b) specifies that "any instrument creating a solar easement" must, at a minimum, include all of the following:

- Description of the dimensions of the easement expressed in measurable terms;
- Restrictions that would impair or obstruct the passage of sunlight through the easement; and
- The terms or conditions, if any, under which the easement may be revised or terminated.

5.4. Limitations of Solar Easements

Solar easements, in theory, can ensure access to unobstructed sunlight for a solar energy system. However, obtaining a solar easement can be difficult. Because a neighboring landowner must grant the easement to a solar energy system owner through a bilateral negotiation, the neighboring landowner may refuse to negotiate or grant a solar easement. Further, easements can be burdensome and costly for individual homeowners to negotiate. Legal costs could exceed the cost savings of the system if neighbors are not willing to grant the easement for free.[115]

Depending on the density of houses in a neighborhood, a prospective solar energy system owner might have to negotiate with several neighbors to ensure access to sunlight.[116] This is often the case in cities or when multiple houses on a slope block access to sunlight. A greater number of parties negotiating typically increases cost and reduces the chance an easement will be created.[117] And, in certain cases, a solar easement is just not possible. Typically, more established neighborhoods were built with no consideration for the need of solar access. Even if parties are willing to negotiate for a solar easement, the design of the neighborhood may make it impossible to place solar collectors in an efficient manner.[118]

5.5. California Government Code Section 66475.3

While easements can be difficult to negotiate on an individual basis, particularly in existing neighborhoods, California Government Code Section 66475.3 provides local governments the ability to require solar easements under certain circumstances in subdivision developments. Under Section 66475.3, legislative bodies of a city or county can require certain subdivisions, by ordinance, to create solar easements to ensure that each parcel has the right to receive sunlight across adjacent parcels or units in the subdivision. Such requirements can only be applied to subdivisions for which a tentative map is necessary.[119] If a local jurisdiction chooses to adopt such an ordinance, it must specify the following pursuant to Section 66475.3:

- Standards for determining the exact dimensions and locations of easements.

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[114] *See* Zipperer v. County of Santa Clara, 2005 Cal. App. Unpub. LEXIS 8982, at *13 (Cal. Ct. App. Sep. 30, 2005).

[115] Adrian J. Bradbrook, *Future Direction in Solar Access Protection*, 19 Envtl. L. 167, 181 (1988).

[116] *Id.* at 180.

[117] *Id.*

[118] *Id.*

[119] California Government Code Section 66426 specifies those subdivisions requiring a tentative and final map.

- Restrictions on vegetation, buildings, and other objects that would obstruct the passage of sunlight through the easement.
- Terms or conditions, if any, for terminating or revising the easement.
- When establishing the easements, consideration shall be given to feasibility, contour, configuration of the parcel to be divided, and cost.
- An easement cannot reduce allowable densities or the percentage of a lot that can occupy buildings or structures under applicable planning or zoning requirements in force at the time the tentative map was filed.
- The ordinance is not applicable to condominium projects that consist of the subdivision of airspace in an existing building where no new structures are added.

5.6. Relevant Case: Zipperer v. County of Santa Clara

In the unpublished portion of its opinion, the *Zipperer v. County of Santa Clara* court specifically discusses the need for written documentation of a solar easement and holds that all solar easements must be written.[120]

The Zipperers built a home with solar heating and cooling systems in the mid-1980s.[121] In 1991, the County of Santa Clara purchased an adjacent property containing a small grove of trees.[122] The trees on this parcel grew significantly after the County acquired the land and began to shade the Zipperer home, limiting their system's performance.[123] In 1997, the Zipperers requested that the County trim or remove the offending shading trees.[124] The County did not respond to the Zipperer's request, and instead passed an ordinance exempting itself from California's Solar Shade Control Act.[125]

In 2004, the Zipperers brought suit against the County under several causes of action, including breach of contract stemming from an implicit right to a solar easement.[126] The Zipperers alleged that the County had implicitly entered into a contract to provide a solar easement by allowing them to construct a solar home according to County requirements.[127] The Zipperers also contended that the County violated this solar easement by allowing the trees on the neighboring lot to grow to a height that shaded their solar energy system.[128]

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[120] 2005 Cal. App. Unpub. LEXIS 8982, at *12–*13 (Cal. Ct. App. Sep. 30, 2005); *see also* Zipperer v. County of Santa Clara, 133 Cal. App. 4th 1013 (2005) (the published opinion).

[121] *Zipperer*, 2005 Cal. App. Unpub. LEXIS at *2.

[122] Id.

[123] Id.

[124] Id.

[125] *Id.* at *25 note 4.

[126] *Id.* at *4.

[127] *Id.* at *9.

[128] Id.

Solar Rights Act

The *Zipperer* court ruled, in the unpublished portion of its opinion, that an express, written instrument is required to create a solar easement in California.[129] The court explained that "the governing provision is section 801.5, which specifically requires a writing in order to create a solar easement."[130] And, despite the fact that the Zipperers argued that other provisions provided exemptions to this written requirement, the court ruled that "section 801.5 plainly is the more specific provision, since it sets forth with particularity the requirements for creation of a solar easement."[131] Therefore, because the Zipperers did not have an express, written instrument, the court held that no solar easement existed.[132]

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129 *Id.* at *13.

130 *Id.* at *14.

131 *Id.* at *15.

132 *Id.* at *12.

6. PRESERVING PASSIVE SOLAR OPPORTUNITIES IN SUBDIVISION DEVELOPMENTS

The Act also aims to preserve the use of passive solar design opportunities in subdivision developments. This intention is codified in California Government Code Section 66473.1 and California Civil Code Section 66475.3.

6.1. California Government Code Section 66473.1

For subdivisions that require a tentative map, California Government Code Section 66473.1(a) requires that such subdivision designs must "provide, to the extent feasible, for future passive or natural heating or cooling opportunities in the subdivision."[133]

Section 66473.1(b) provides the following examples of natural or passive heating and cooling opportunities:

- Heating – Design of lot size and configuration to permit orientation of a structure in an east-west alignment for southern exposure.
- Cooling – Design of lot size and configuration to permit orientation of a structure to take advantage of shade or prevailing breezes.

Section 66473.1 provides additional guidance on passive heating or cooling opportunities. When considering such opportunities, developers and permitting agencies should take into account the local climate, contour, and configuration of the parcel to be divided, as well as other design and improvement requirements.[134] Such consideration should not reduce "allowable densities or the percentage of a lot that may be occupied by a building or structure under applicable planning and zoning in effect at the time the tentative map is filed."[135]

Section 66473.1(d) exempts certain condominiums from this requirement. Specifically, "condominium projects which consist of the subdivision of airspace in an existing building when no new structures are added" are exempt from the requirements of this section.[136]

[133] California Government Code Section 66426 specifies those subdivisions requiring a tentative and final map.

[134] § 66473.1(c).

[135] Id.

[136] § 66473.1(d).

7. CONCLUSION

The Act establishes rights for homeowners and businesses to access sunlight for the purpose of creating thermal or electric energy. It defines how an HOA and a local government can limit solar energy system installations; permits a property owner to seek a solar easement to ensure access to sunlight across adjacent properties; and allows governments to preserve passive solar heating and cooling opportunities by requiring developers to create easements in certain subdivisions.

We revisit this landmark law because its provisions are, by and large, not well understood by the general public. Additionally, California's solar market is expected to grow significantly in the coming decade as a result of expanded financial incentives for solar energy systems. As more homes and businesses install solar energy systems and local governments pursue renewable energy solutions, understanding and clarifying the provisions of the Act will only become more relevant and important.

This paper provides information and analysis on the Act to help parties understand the provisions of the law and to understand how the law affects them. Our research should help solar collector owners determine if they are eligible for protections under the Act, HOAs determine if they are liable for an allegation brought under the Act, and cities and counties understand their role in promoting solar energy systems and enforcing solar access provisions under the Act.

8. APPENDIX

8.1. Other Resources

For more information about the Act, the following articles and books are a useful resource:

- Adrian J. Bradbrook, *Future Direction in Solar Access Protection*, 19 Envtl. L. 167 (1988). A law review article generally discussing solar access laws.
- Kenneth H. Burke & Bruce N. Lemons, *Simplified Solar Easements*, 2 Solar L. Rep. 320 (1980–1981). A law review article that discusses solar easement laws.
- Melvin M. Eisenstadt & Albert E. Utton, *Solar Rights and Their Effect on Solar Heating and Cooling*, 16 Nat. Resources J. 363 (1976). An article that examines the legal history and theories behind solar easements and right to light.
- *Energy; Incentives for the Use of Solar Energy*, 10 Pac. L.J. 478 (1979). A review of the Solar Rights Act and Solar Shade Control Act legislation. It also discusses possible legal problems and enforcement of solar easements.
- Eugene J. Riordan & Robert L. Hiller, *Describing the Solar Space in a Solar Easement*, 2 Solar L. Rep. 299 (1980-1981). A law review article that discusses the technicalities to be agreed upon when forming a solar easement.
- Thomas Starrs et al., *Bringing Solar Energy to the Planned Community: A Handbook on Rooftop Solar Systems and Private Land Use Restrictions*, http://www.sdenergy.org/uploads/Final_CC&R_Handbook_1-01.pdf.
- Robert L. Thayer, *Solar Access, "It's The Law!": A Manual on California's Solar Access Laws for Planners, Designers, Developers, and Community Officials* 9–13, (1981). A handbook that details solar laws and their practical applicability in subdivision development.

9. FULL TEXT OF STATUTES

The Solar Rights Act comprises the following California sections of law: California Civil Code Sections 714 and 714.1, California Civil Code Section 801, California Civil Code Section 801.5, California Government Code Section 65850.5, California Health and Safety Code Section 17959.1, California Government Code Section 66475.3, and California Government Code Section 66473.1. These sections of law are reprinted here in their entirety.[137]

9.1. California Civil Code Section 714

(a) Any covenant, restriction, or condition contained in any deed, contract, security instrument, or other instrument affecting the transfer or sale of, or any interest in, real property, and any provision of a governing document, as defined in subdivision (j) of Section 1351, that effectively prohibits or restricts the installation or use of a solar energy system is void and unenforceable.

(b) This section does not apply to provisions that impose reasonable restrictions on solar energy systems. However, it is the policy of the state to promote and encourage the use of solar energy systems and to remove obstacles thereto. Accordingly, reasonable restrictions on a solar energy system are those restrictions that do not significantly increase the cost of the system or significantly decrease its efficiency or specified performance, or that allow for an alternative system of comparable cost, efficiency, and energy conservation benefits.

(c) (1) A solar energy system shall meet applicable health and safety standards and requirements imposed by state and local permitting authorities.

(2) A solar energy system for heating water shall be certified by the Solar Rating Certification Corporation (SRCC) or other nationally recognized certification agencies. SRCC is a nonprofit third party supported by the United States Department of Energy. The certification shall be for the entire solar energy system and installation.

(3) A solar energy system for producing electricity shall also meet all applicable safety and performance standards established by the National Electrical Code, the Institute of Electrical and Electronics Engineers, and accredited testing laboratories such as Underwriters Laboratories and, where applicable, rules of the Public Utilities Commission regarding safety and reliability.

(d) For the purposes of this section:

(1) (A) For solar domestic water heating systems or solar swimming pool heating systems that comply with state and federal law, "significantly" means an amount exceeding 20 percent of the cost of the system or decreasing the efficiency of the solar energy system by an amount exceeding 20 percent, as originally specified and proposed.

(B) For photovoltaic systems that comply with state and federal law, "significantly" means an amount not to exceed two thousand dollars ($2,000) over the system cost as originally specified and

[137] All current California laws can be found at http://www.leginfo.ca.gov.

proposed, or a decrease in system efficiency of an amount exceeding 20 percent as originally specified and proposed.

(2) "Solar energy system" has the same meaning as defined in paragraphs (1) and (2) of subdivision (a) of Section 801.5.

(e) (1) Whenever approval is required for the installation or use of a solar energy system, the application for approval shall be processed and approved by the appropriate approving entity in the same manner as an application for approval of an architectural modification to the property, and shall not be willfully avoided or delayed.

(2) For an approving entity that is a homeowners' association, as defined in subdivision (a) of Section 1351, and that is not a public entity, both of the following shall apply:

(A) The approval or denial of an application shall be in writing.

(B) If an application is not denied in writing within 60 days from the date of receipt of the application, the application shall be deemed approved, unless that delay is the result of a reasonable request for additional information.

(f) Any entity, other than a public entity, that willfully violates this section shall be liable to the applicant or other party for actual damages occasioned thereby, and shall pay a civil penalty to the applicant or other party in an amount not to exceed one thousand dollars ($1,000).

(g) In any action to enforce compliance with this section, the prevailing party shall be awarded reasonable attorney's fees.

(h) (1) A public entity that fails to comply with this section may not receive funds from a state-sponsored grant or loan program for solar energy. A public entity shall certify its compliance with the requirements of this section when applying for funds from a state-sponsored grant or loan program.

(2) A local public entity may not exempt residents in its jurisdiction from the requirements of this section.

9.2. California Civil Code Section 714.1

Notwithstanding Section 714**,** any association, as defined in Section 1351, may impose reasonable provisions which:

(a) Restrict the installation of solar energy systems installed in common areas, as defined in Section 1351, to those systems approved by the association.

(b) Require the owner of a separate interest, as defined in Section 1351, to obtain the approval of the association for the installation of a solar energy system in a separate interest owned by another.

(c) Provide for the maintenance, repair, or replacement of roofs or other building components.

(d) Require installers of solar energy systems to indemnify or reimburse the association or its members for loss or damage caused by the installation, maintenance, or use of the solar energy system.

9.3. California Civil Code Section 801

The following land burdens, or servitudes upon land, may be attached to other land as incidents or appurtenances, and are then called easements:

1. The right of pasture;

2. The right of fishing;

3. The right of taking game;

4. The right-of-way;

5. The right of taking water, wood, minerals, and other things;

6. The right of transacting business upon land;

7. The right of conducting lawful sports upon land;

8. The right of receiving air, light, or heat from or over, or discharging the same upon or over land;

9. The right of receiving water from or discharging the same upon land;

10. The right of flooding land;

11. The right of having water flow without diminution or disturbance of any kind;

12. The right of using a wall as a party wall;

13. The right of receiving more than natural support from adjacent land or things affixed thereto;

14. The right of having the whole of a division fence maintained by a coterminous owner;

15. The right of having public conveyances stopped, or of stopping the same on land;

16. The right of a seat in church;

17. The right of burial;

18. The right of receiving sunlight upon or over land as specified in Section 801.5.

9.4. California Civil Code Section 801.5

(a) The right of receiving sunlight as specified in subdivision 18 of Section 801 shall be referred to as a solar easement. "Solar easement" means the right of receiving sunlight across real property of another for any solar energy system.

As used in this section, "solar energy system" means either of the following:

(1) Any solar collector or other solar energy device whose primary purpose is to provide for the collection, storage, and distribution of solar energy for space heating, space cooling, electric generation, or water heating.

(2) Any structural design feature of a building, whose primary purpose is to provide for the collection, storage, and distribution of solar energy for electricity generation, space heating or cooling, or for water heating.

(b) Any instrument creating a solar easement shall include, at a minimum, all of the following:

(1) A description of the dimensions of the easement expressed in measurable terms, such as vertical or horizontal angles measured in degrees, or the hours of the day on specified dates during which direct sunlight to a specified surface of a solar collector, device, or structural design feature may not be obstructed, or a combination of these descriptions.

(2) The restrictions placed upon vegetation, structures, and other objects that would impair or obstruct the passage of sunlight through the easement.

(3) The terms or conditions, if any, under which the easement may be revised or terminated.

9.5. California Government Code Section 65850.5

(a) The implementation of consistent statewide standards to achieve the timely and cost-effective installation of solar energy systems is not a municipal affair, as that term is used in Section 5 of Article XI of the California Constitution, but is instead a matter of statewide concern. It is the intent of the Legislature that local agencies not adopt ordinances that create unreasonable barriers to the installation of solar energy systems, including, but not limited to, design review for aesthetic purposes, and not unreasonably restrict the ability of homeowners and agricultural and business concerns to install solar energy systems. It is the policy of the state to promote and encourage the use of solar energy systems and to limit obstacles to their use. It is the intent of the Legislature that local agencies comply not only with the language of this section, but also the legislative intent to encourage the installation of solar energy systems by removing obstacles to, and minimizing costs of, permitting for such systems.

(b) A city or county shall administratively approve applications to install solar energy systems through the issuance of a building permit or similar nondiscretionary permit. Review of the application to install a solar energy system shall be limited to the building official's review of whether it meets all health and safety requirements of local, state, and federal law. The requirements of local law shall be limited to those standards and regulations necessary to ensure that the solar energy system will not have a specific, adverse impact upon the public health or safety. However, if the building official of the city or county has a good faith belief that the solar energy system could have a specific, adverse impact upon the public health and safety, the city or county may require the applicant to apply for a use permit.

(c) A city or county may not deny an application for a use permit to install a solar energy system unless it makes written findings based upon substantial evidence in the record that the proposed installation would have a specific, adverse impact upon the public health or safety, and there is no feasible method to satisfactorily mitigate or avoid the specific, adverse impact. The findings shall include the basis for the rejection of potential feasible alternatives of preventing the adverse impact.

(d) The decision of the building official pursuant to subdivisions (b) and (c) may be appealed to the planning commission of the city or county.

(e) Any conditions imposed on an application to install a solar energy system shall be designed to mitigate the specific, adverse impact upon the public health and safety at the lowest cost possible.

(f) (1) A solar energy system shall meet applicable health and safety standards and requirements imposed by state and local permitting authorities.

(2) A solar energy system for heating water shall be certified by the Solar Rating Certification Corporation (SRCC) or other nationally recognized certification agency. SRCC is a nonprofit third party supported by the United States Department of Energy. The certification shall be for the entire solar energy system and installation.

(3) A solar energy system for producing electricity shall meet all applicable safety and performance standards established by the National Electrical Code, the Institute of Electrical and Electronics Engineers, and accredited testing laboratories such as Underwriters Laboratories and, where applicable, rules of the Public Utilities Commission regarding safety and reliability.

(g) The following definitions apply to this section:

(1) "A feasible method to satisfactorily mitigate or avoid the specific, adverse impact" includes, but is not limited to, any cost-effective method, condition, or mitigation imposed by a city or county on another similarly situated application in a prior successful application for a permit. A city or county shall use its best efforts to ensure that the selected method, condition, or mitigation meets the conditions of subparagraphs (A) and (B) of paragraph (1) of subdivision (d) of Section 714 of the Civil Code.

(2) "Solar energy system" has the same meaning set forth in paragraphs (1) and (2) of subdivision (a) of Section 801.5 of the Civil Code.

(3) A "specific, adverse impact" means a significant, quantifiable, direct, and unavoidable impact, based on objective, identified, and written public health or safety standards, policies, or conditions as they existed on the date the application was deemed complete.

9.6. California Health & Safety Code Section 17959.1

(a) A city or county shall administratively approve applications to install solar energy systems though the issuance of a building permit or similar nondiscretionary permit. However, if the building official of the city or county has a good faith belief that the solar energy system could have a specific, adverse impact upon the public health and safety, the city or county may require the applicant to apply for a use permit.

(b) A city or county may not deny an application for a use permit to install a solar energy system unless it makes written findings based upon substantial evidence in the record that the proposed installation would have a specific, adverse impact upon the public health or safety, and there is no feasible method to satisfactorily mitigate or avoid the specific, adverse impact. This finding shall include the basis for the rejection of potential feasible alternatives of preventing the adverse impact.

(c) Any conditions imposed on an application to install a solar energy system must be designed to mitigate the specific, adverse impact upon the public health and safety at the lowest cost possible.

(d) (1) A solar energy system shall meet applicable health and safety standards and requirements imposed by state and local permitting authorities.

(2) A solar energy system for heating water shall be certified by the Solar Rating Certification Corporation (SRCC) or other nationally recognized certification agency. SRCC is a nonprofit third party supported by the United States Department of Energy. The certification shall be for the entire solar energy system and installation.

(3) A solar energy system for producing electricity shall meet all applicable safety and performance standards established by the National Electrical Code, the Institute of Electrical and Electronics Engineers,

and accredited testing laboratories such as Underwriters Laboratories and, where applicable, rules of the Public Utilities Commission regarding safety and reliability.

(e) The following definitions apply to this section:

(1) "A feasible method to satisfactorily mitigate or avoid the specific, adverse impact" includes, but is not limited to, any cost effective method, condition, or mitigation imposed by a city or county on another similarly situated application in a prior successful application for a permit. A city or county shall use its best efforts to ensure that the selected method, condition, or mitigation meets the conditions of subparagraphs (A) and (B) of paragraph (1) of subdivision (d) of Section 714 of the Civil Code.

(2) "Solar energy system" has the meaning set forth in paragraphs (1) and (2) of subdivision (a) of Section 801.5 of the Civil Code.

(3) A "specific, adverse impact" means a significant, quantifiable, direct, and unavoidable impact, based on objective, identified, and written public health or safety standards, policies, or conditions as they existed on the date the application was deemed complete.

9.7. California Government Code Section 66475.3

For divisions of land for which a tentative map is required pursuant to Section 66426, the legislative body of a city or county may by ordinance require, as a condition of the approval of a tentative map, the dedication of easements for the purpose of assuring that each parcel or unit in the subdivision for which approval is sought shall have the right to receive sunlight across adjacent parcels or units in the subdivision for which approval is sought for any solar energy system, provided that such ordinance contains all of the following:

(1) Specifies the standards for determining the exact dimensions and locations of such easements.

(2) Specifies any restrictions on vegetation, buildings and other objects which would obstruct the passage of sunlight through the easement.

(3) Specifies the terms or conditions, if any, under which an easement may be revised or terminated.

(4) Specifies that in establishing such easements consideration shall be given to feasibility, contour, configuration of the parcel to be divided, and cost, and that such easements shall not result in reducing allowable densities or the percentage of a lot which may be occupied by a building or a structure under applicable planning and zoning in force at the time such tentative map is filed.

(5) Specifies that the ordinance is not applicable to condominium projects which consist of the subdivision of airspace in an existing building where no new structures are added.

For the purposes of this section, "solar energy systems" shall be defined as set forth in Section 801.5 of the Civil Code.

For purposes of this section, "feasibility" shall have the same meaning as set forth in Section 66473.1 for the term "feasible".

9.8. California Government Code Section 66473.1

(a) The design of a subdivision for which a tentative map is required pursuant to Section 66426 shall provide, to the extent feasible, for future passive or natural heating or cooling opportunities in the subdivision.

(b) (1) Examples of passive or natural heating opportunities in subdivision design, include design of lot size and configuration to permit orientation of a structure in an east-west alignment for southern exposure.

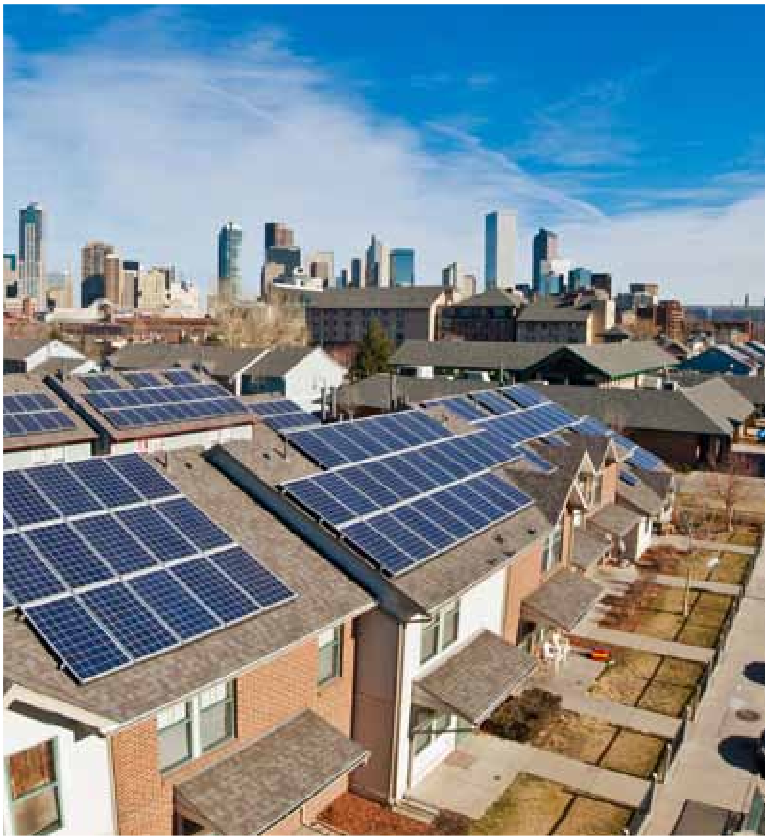
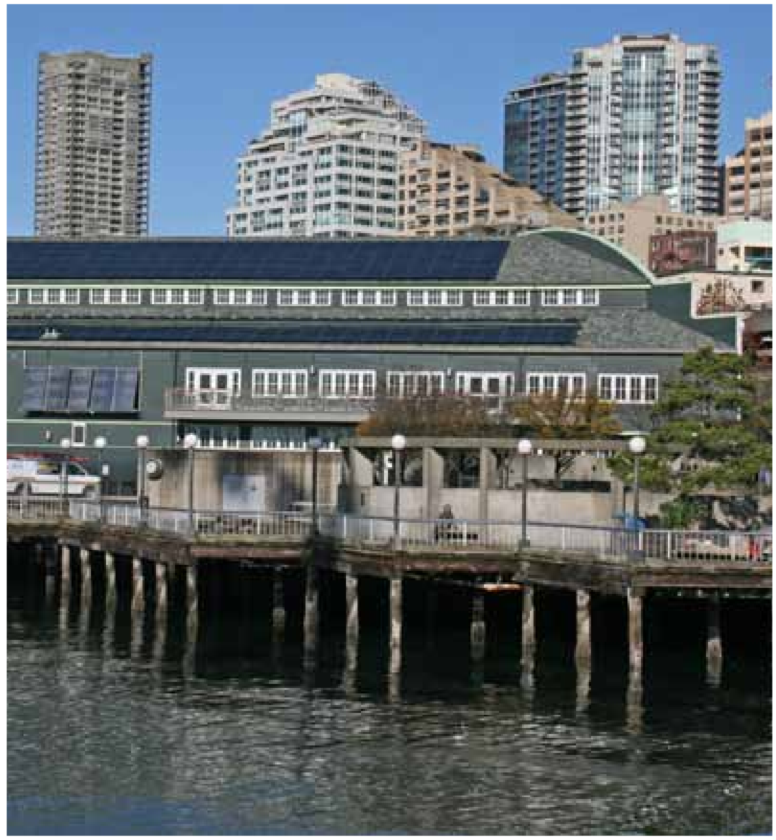
(2) Examples of passive or natural cooling opportunities in subdivision design include design of lot size and configuration to permit orientation of a structure to take advantage of shade or prevailing breezes.

(c) In providing for future passive or natural heating or cooling opportunities in the design of a subdivision, consideration shall be given to local climate, to contour, to configuration of the parcel to be divided, and to other design and improvement requirements, and that provision shall not result in reducing allowable densities or the percentage of a lot that may be occupied by a building or structure under applicable planning and zoning in effect at the time the tentative map is filed.

(d) The requirements of this section do not apply to condominium projects which consist of the subdivision of airspace in an existing building when no new structures are added.

(e) For the purposes of this section, "feasible" means capable of being accomplished in a successful manner within a reasonable period of time, taking into account economic, environmental, social and technological factors.



Shining Cities

At the Forefront of America's Solar Energy Revolution

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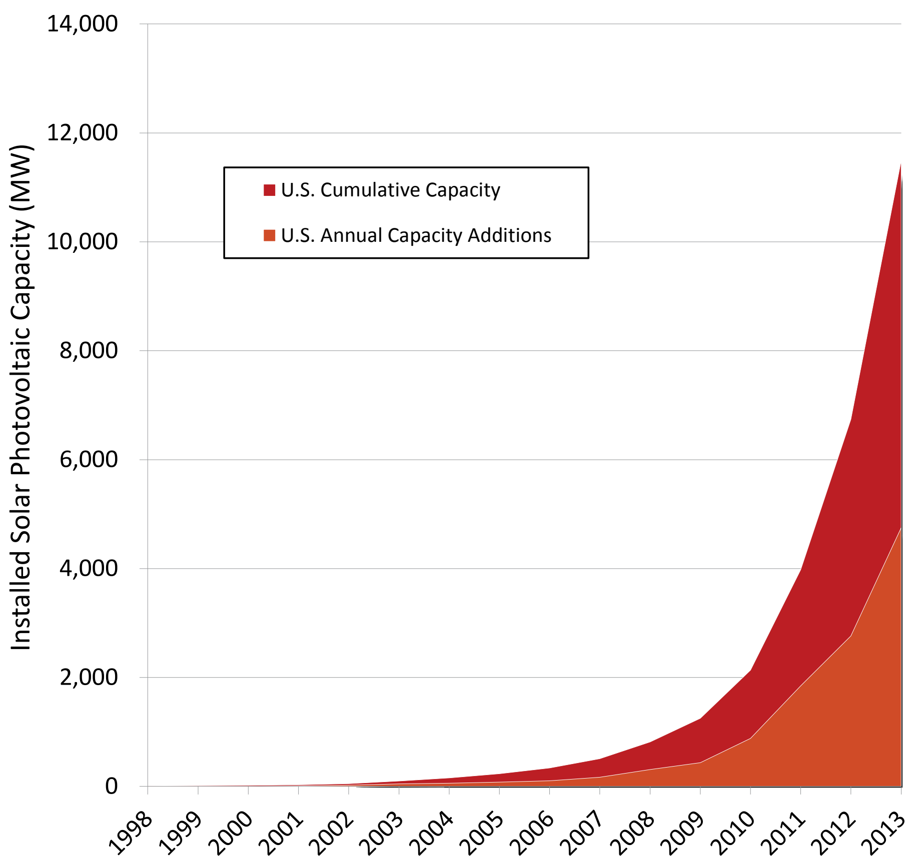
Executive Summary

Solar power is on the rise across the country. The United States has more than 200 times as much solar photovoltaic (PV) capacity installed today as it did in 2002. With solar module prices coming down, increasing national awareness of solar energy, and a growing legion of solar businesses large and small, solar power is emerging as a mainstream energy solution with widespread benefits for our health, our economy and the environment.

America's major cities are helping to lead this clean energy revolution. Forward-thinking local governments and large cities in leading states are benefiting from smart policies that encourage investment in solar PV installations and the growth of local jobs.

This report provides a first-of-its-kind comparative look at the growth of solar power in major American cities. **Just 20 cities, representing just 0.1 percent of the land area of the United States, account for**

Figure ES-1. Annual and Cumulative Installed Photovoltaic (PV) Capacity through 2013, United States



7 percent of solar PV capacity in the United States. These top 20 cities contain more solar power today than was installed in the entire U.S. just six years ago.

Solar energy brings important benefits to cities.

- **Solar energy avoids pollution**—Pollution-free energy from the sun displaces fossil fuel-powered energy sources, reducing a major source of pollution that contributes to urban smog and global warming. Outdoor air pollutants endanger the health of city residents, and many urban centers are vulnerable to the global warming-induced threats of sea-level rise, increasingly frequent and severe extreme weather events, and the public health impacts of heat waves. Rooftop solar energy also increases city resilience to extreme weather events, which are only due to get worse with increased global warming. For example, solar energy can power cities when drought strikes without diverting precious water resources and help prevent blackouts by reducing strain on the grid. As the electric system evolves, solar panels will be able to provide backup power during power outages caused by storms or other disasters.
- **Solar energy protects consumers**—Cities often depend on electricity transmitted from power plants hundreds of miles away to meet

Table ES-1. Top 20 Solar Cities by Total Installed Solar PV Capacity, End of 2013*

Principal City	State	Cumulative Solar PV Capacity (MW)	Cumulative Solar PV Capacity Rank
Los Angeles	CA	132	1
San Diego	CA	107	2
Phoenix	AZ	96	3
San Jose	CA	94	4
Honolulu	HI	91	5
San Antonio	TX	84	6
Indianapolis	IN	56	7
New York	NY	33	8
San Francisco	CA	26	9
Denver	CO	25	10
New Orleans	LA	22	11
Sacramento	CA	16	12
Jacksonville	FL	16	13
Albuquerque	NM	16	14
Portland	OR	15	15
Austin	TX	13	16
Las Vegas	NV	13	17
Newark	NJ	13	18
Raleigh	NC	12	19
Boston	MA	12	20

** This includes all solar PV capacity (rooftop and utility-scale solar installations) within the city limits of each city. See methodology for an explanation of how these rankings were calculated. See Appendix B for city-specific sources of data.*

local demand. Using local solar energy reduces the need for electricity transmission and the need for costly and inefficient "peaking" power plants. Solar energy also typically supplies electricity on hot, sunny days when grids are under the most strain and electricity is most expensive. In addition, since there are no fuel costs associated with solar energy, it can reduce the vulnerability of city economies to price increases for fossil fuels.

- **Solar energy helps the economy**—Solar power creates local jobs in solar installations and manufacturing. Solar industry employment grew 10 times faster than the national average growth in employment in 2013 and employed 142,000 Americans as of November 2013.

The top 20 cities have a total installed solar PV capacity of over 890 MW and are located in almost every region of the U.S.

On a per-capita basis, Honolulu is the leading solar city, followed by San Jose, and Wilmington, Delaware.

America's leading solar cities are increasing their use of solar energy in a variety of ways. Some cities are focusing on distributed solar PV on homes and small businesses, others are building utility-scale solar power plants, while still others are developing solar energy at the neighborhood scale or through community projects. What makes these top cities solar leaders?

- **Commitment from local governments**. Cities can lead and catalyze local markets by installing solar power on city buildings and setting ambitious but achievable targets for solar energy. Leading solar cities, including Denver and Portland, are driving solar growth starting with their public buildings.

Figure ES-2. Map of 57 Principal Cities Ranked by Cumulative Installed Solar PV Capacity, End of 2013

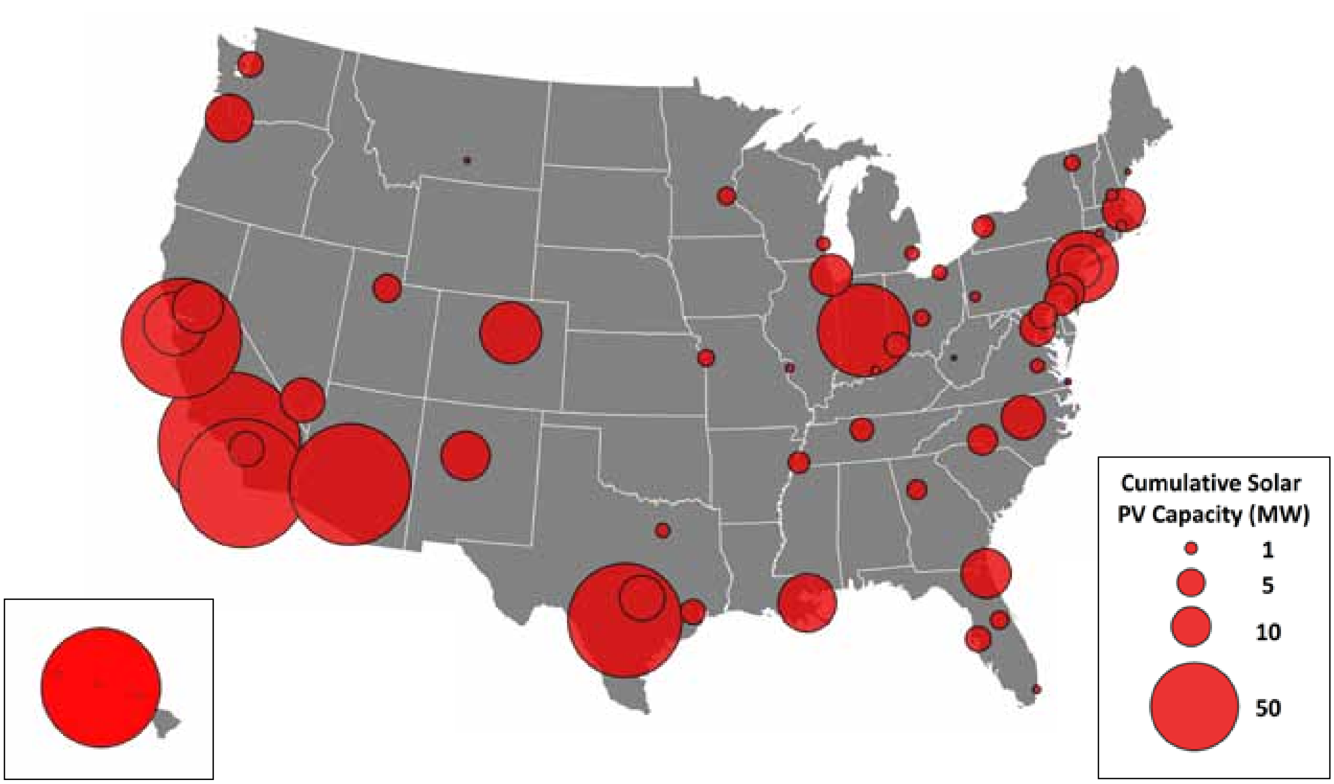


Table ES-2. The "Solar Stars" (Cities with More Than 50 Watts of Installed Solar PV Capacity per Person, End of 2013)

Principal City	State	Cumulative Solar PV Capacity (MW)	Solar PV Capacity per Capita (Watts/Person)	Solar PV Capacity per Capita Rank
Honolulu	HI	91	265	1
San Jose	CA	94	97	2
Wilmington	DE	7	96	3
San Diego	CA	107	81	4
Indianapolis	IN	56	68	5
Phoenix	AZ	96	65	6
San Antonio	TX	84	62	7
New Orleans	LA	22	60	8

- **Support from city policies and programs**. Cities can create policies that promote solar power in their communities. Cities can encourage local lending for solar projects, provide predictable and accessible tax incentives that make solar energy more affordable and welcoming to businesses, and adopt solar-friendly permitting policies and building codes. New York City, for example, has a property tax credit for residents who install solar panels. Cities can also run "Solarize" programs that use collective purchasing and educational campaigns to help neighbors "go solar" together, as Portland, Oregon did, or create programs to facilitate solar project financing like Property Assessed Clean Energy (PACE) financing.

- **Partnership with local utilities**. Municipal utilities in several cities have driven the growth of solar power by setting renewable energy goals and offering attractive financial incentives for solar projects. Austin Energy, the municipal utility serving Austin, has set a goal of installing 200 MW of solar power by 2020 and offers an array of solar financing options and monetary incentives to its customers. Seattle City Light allows its customers to invest in community solar projects that are not located on their properties but whose output is still credited on their utility bill. Other cities have effectively partnered with investor-owned utilities to incentivize solar power. New York City partnered with Con Edison, its local investor-owned utility, to connect solar power to the city grid for the first time and create designated "Solar Empowerment Zones" where solar power could deliver the most benefits.

- **Strong state-level policies.** New Jersey, Delaware and Massachusetts have among the strongest standards in the country, boosting the solar capacity of cities such as Newark, New Jersey, Wilmington, Delaware and Boston, Massachusetts. Hawaii, California, Arizona and New York also benefit from strong state policies that make them home to some of the most prominent solar cities. Net metering policies that allow solar producers to receive the full benefits of their solar power production are important for a robust solar market; states should also allow for virtual net metering that facilitates shared solar projects.

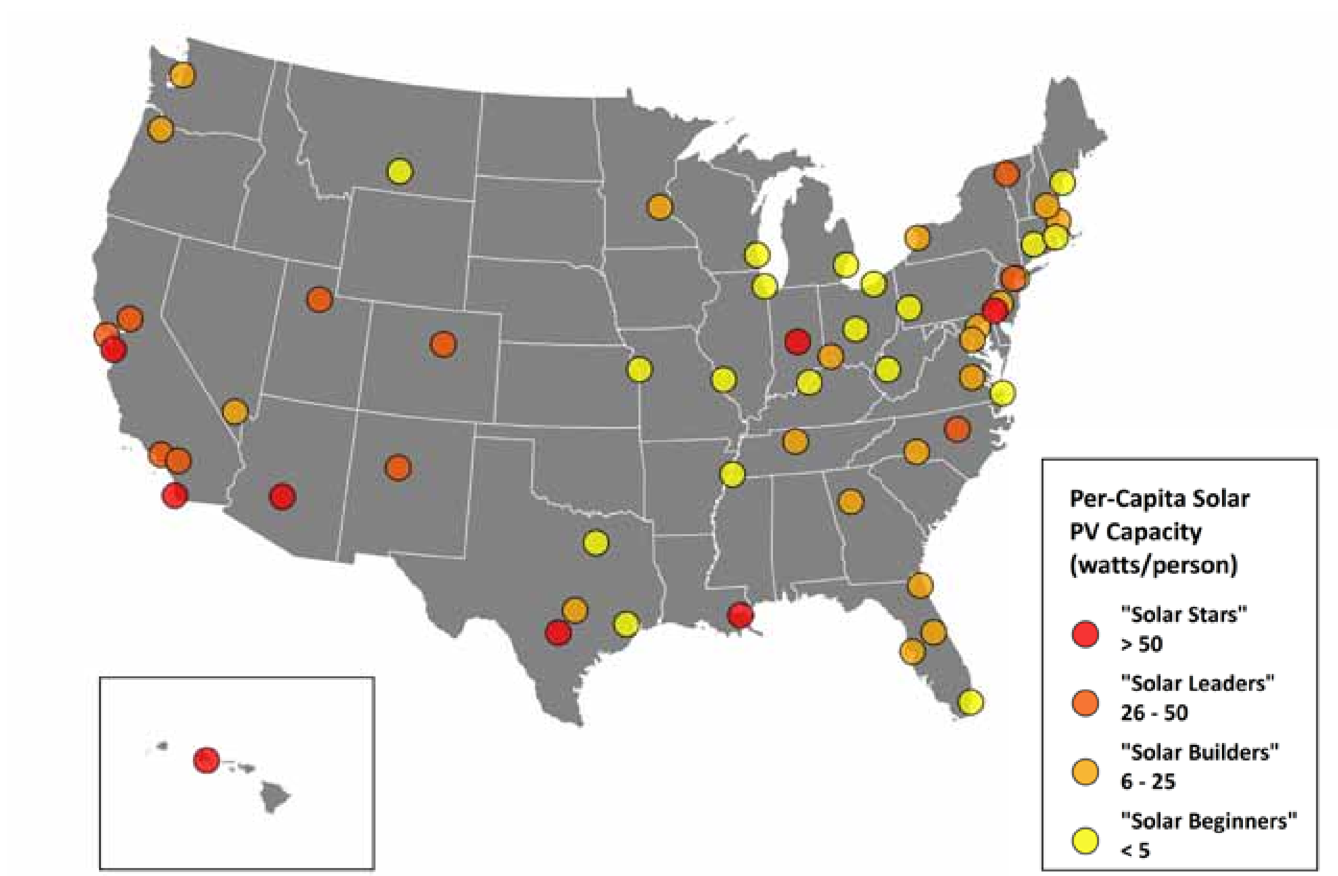
- **Support from federal programs.** Federal renewable energy tax credits and funding from federal programs like the Solar America Cities program, the Energy Efficiency and Conservation Block

Grant program and the U.S. Department of Energy's Sunshot Initiative provide support for local solar power growth and valuable technical assistance to local governments.

America's leading cities have made significant progress but have just begun to tap solar energy's immense potential. **Strong public policies at every level of government can help America continue to harness clean solar energy and overcome legislative and regulatory barriers to distributed generation.** To achieve America's full solar potential:

- **Local governments** should follow the lead of America's top solar cities by adopting programs that promote the rapid expansion of solar power and by demanding that state and federal officials and investor-owned utilities facilitate that expansion.
- **State governments** should set ambitious goals for solar energy and adopt policies to meet them. State governments should also use their role as the primary regulators of electric utilities to encourage utility investments in solar energy and implement rate structures that maximize the benefits of solar energy to consumers. States can streamline permitting, inspections and net metering rules to reduce the non-equipment costs of getting solar power on rooftops. States should require that upcoming investments in the electric grid are designed to ensure that clean, distributed energy such as solar power plays a larger role.
- **The federal government** should continue to provide long-term support for solar power through tax credits and other incentives. The federal government should continue to support

Figure ES-3. Map of 57 Principal Cities Ranked by Installed Solar PV Capacity per Person, End of 2013



research, development and deployment efforts designed to reduce the cost of solar energy and related storage and smart grid technologies; this will enable more solar energy to be reliably incorporated into the electric grid. The federal government should continue to offer programs like the Solar America Cities program, the Energy Efficiency Conservation Block Grant program and the U.S. Department of Energy's Sunshot Initiative, which provide support and technical assistance while fostering innovations that drive solar development at the state and local levels.

- **All levels of government** should lead by example by installing solar energy technologies on government buildings.

Photo: Social Security Administration via NREl Image Gallery

Just 20 cities, representing just 0.1 percent of the land area of the United States, account for 7 percent of solar PV capacity in the United States.

Introduction

Portland, Oregon is not known for its sunshine. Portland's reputation for rainy weather is only partially deserved—summers are often sunny, compensating for the frequently cloudy winters. Nonetheless, the city with the reputation for gray skies has emerged as one of the nation's bright spots for solar energy—largely due to the creative efforts of local residents and city officials.

Portland's path to solar leadership began in 2007 when the city was selected for the federal government's "Solar America Cities" program. This program provided the city with funding and support for its efforts to develop local solar power.[1] Two years later, when a neighborhood in Portland wanted to install solar panels, they partnered with the non-profit Energy Trust of Oregon to hold workshops, select a contractor and purchase the panels collectively, cutting costs for themselves and their solar installer.[2]

The successful collective purchasing model was quickly replicated citywide. Portland's Bureau of Planning and Sustainability worked with Portland's Neighborhood Coalition network, the Energy Trust of Oregon and Solar Oregon to establish the "Solarize Portland" program.[3] Between 2009 and 2011, six Solarize Portland campaigns empowered neighborhood associations to work with residents. These campaigns helped residents learn about solar incentives and provided them access to solar panels, supplied by contractors that obtained a large volume of business at low marketing costs.[4]

As a result of these campaigns, Portland added 1.7 megawatts (MW) of solar power on 560 homes in the city between 2009 and 2011.[5] The "solarize" model has since been adopted by other cities, such as Boston and Seattle.[6]

However, the city of Portland didn't stop with collective purchasing. City officials are working to streamline the solar permitting process by launch-

Overall, city action strengthened by state policy has allowed Portland to jump from less than 1 MW of installed solar PV capacity in 2007 to more than 15 MW of solar PV capacity at the end of 2013.

ing online permitting in 2016 and have launched "Solar Forward," a crowd-sourcing initiative that asks community members to donate money to fund solar projects on community facilities.[7] Portland's efforts have been supported by state-level policies, including a renewable energy standard with specific requirements for solar energy, tax credits for residential and some commercial solar energy installations, and a pilot feed-in tariff program.

Overall, city action strengthened by state policy has allowed Portland to jump from less than 1 MW of installed solar PV capacity in 2007 to more than 15 MW of solar PV capacity at the end of 2013.[8] This puts Portland in the top 15 of the 57 major cities we surveyed in this report.

Portland is not the only U.S. city to use creative and strong public policies to vault into solar leadership. Other cities in every region of the United States have experienced dramatic progress in recent years in expanding solar energy.

In July 2013, we released *Lighting the Way*, which identified the nation's top states for solar energy and linked their success to the adoption of smart public policies that have fueled the growth of solar energy. In this report, we provide the first national-scale comparison of solar photovoltaic (PV) installations in some of America's largest cities.

The lesson of cities like Portland is clear: cities that take effective action to lower the barriers to solar energy development for their residents and businesses can make a dramatic leap toward a cleaner energy economy.

That pathway is open to any city that wishes to pursue it. For the sake of the environment, public health and the health of local economies, the time has come for all states and local governments to follow the example of the nation's leading "solar cities" by finding new and creative ways to encourage their residents, businesses and local utilities to "go solar."

Solar Energy Is Good for the Environment, Consumers and the Economy in America's Cities

Solar energy makes sense for America—especially American cities. Each new solar panel helps to clean our air, fight global warming, boost the economy, and create jobs. American cities have vast potential for solar power, with millions of empty rooftops, parking lots and brownfields ideal for solar energy development.

Solar Power Prevents Smog and Global Warming Pollution

America's cities bear the brunt of much of the environmental damage caused by our reliance on fossil fuels. According to the American Lung Association, more than 131 million people live in counties with dangerous levels of ozone. In these areas, many of them urban, simply breathing the air puts residents at increased risk for asthma and cardiovascular issues.[9] The Institute of Physics estimates that human-caused outdoor air pollution causes more than 2 million deaths worldwide each year.[10]

Similarly, many American cities face significant threats from global warming:

- Coastal cities will experience the impacts of **rising sea levels**. Five feet of sea level rise, which could happen in the next century if global warming pollution continues unabated, could flood almost 90 percent of New Orleans, 95 percent of Miami Beach, Florida, and 11 percent of Wilmington, Delaware.[11]
- Global warming is expected to increase the severity of **extreme weather events** that threaten cities. More than 76 million Americans live in counties affected by weather-related disasters in 2012. There were at least 11 disasters in 2012 that each inflicted more than $1 billion in damage, including Hurricane Sandy, which caused estimated damages of at least $50 billion.[12]
- More **severe heat waves and fire seasons** will affect America's cities. More than 1.2 million homes in the western United States, representing $189 billion in property value, are at risk for wildfire damage, with Los Angeles containing the most properties at risk.[13]

Fossil fuel power plants are significant contributors to both of these threats. Power plants emit dangerous air pollutants including nitrogen oxides, which contribute to the formation of ozone "smog"; sulfur dioxide, which contributes to the formation of small particles in the air that can trigger respiratory diseases such as bronchitis and emphysema; and mercury, a potent neurotoxicant.[14] Producing more electricity with clean solar power instead of fossil-fueled power plants is an important step toward reducing emissions of these air pollutants.

Power plants are also America's largest source of carbon dioxide, the leading global warming pollutant. If the 50 dirtiest U.S. power plants were an independent nation, they would be the seventh-largest emitter of carbon dioxide pollution in the world.[15] (See Figure 1.) In 2011, U.S. power plants were responsible for one-third of the nation's greenhouse gas emissions, which include carbon dioxide emissions.[16]

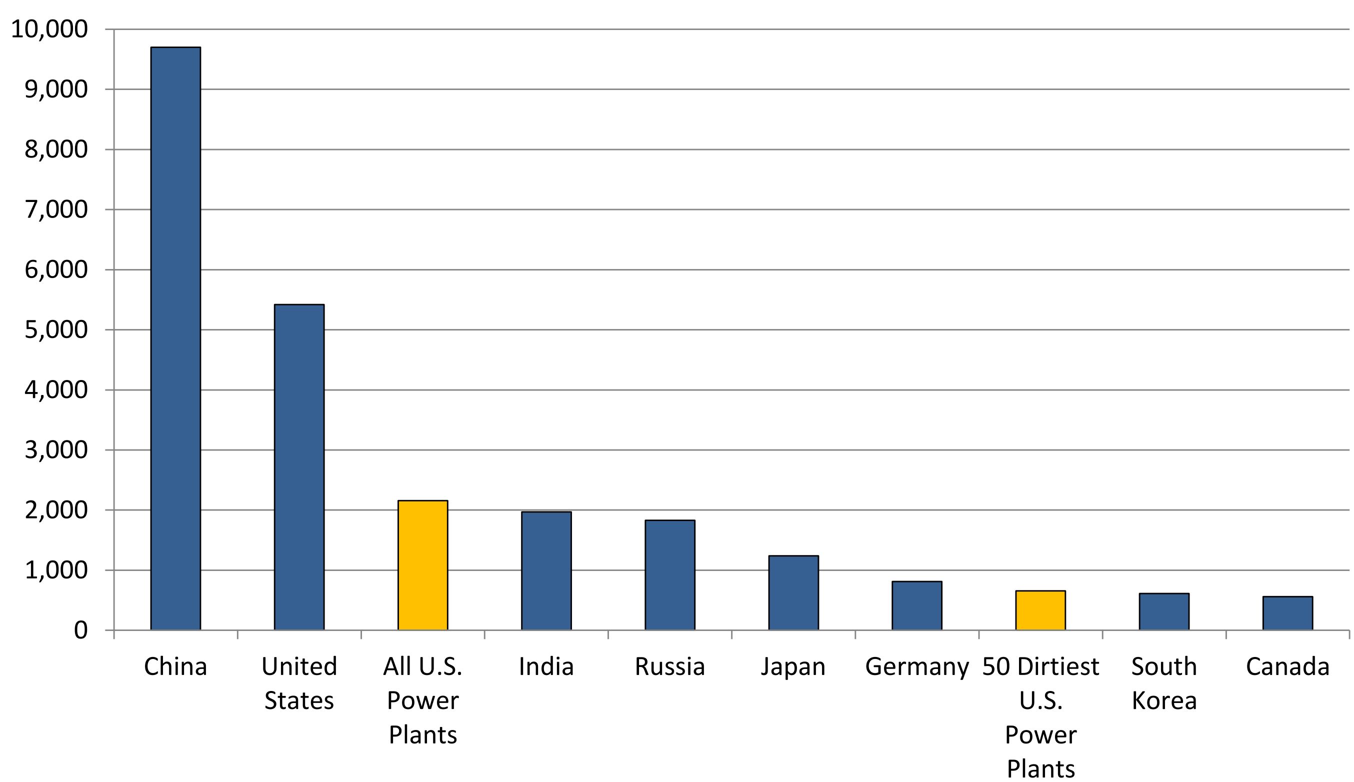
Solar power generation produces no global warming pollution. Even when emissions from manufacturing, transportation and installation of solar panels are included, solar power produces 96 percent less global warming pollution than coal-fired power plants over their entire life-cycle, and 91 percent less global warming pollution than natural gas-fired power plants.[18]

By reducing the need for electricity from fossil fuel-fired power plants, solar power reduces the threat posed by global warming and helps to clean the nation's air.

Solar Energy Increases City Resiliency

Rooftop solar energy also increases city resiliency to severe storms and heat waves, which global warming will worsen. If transmission lines are disrupted from a severe storm or heat wave, solar energy attached to batteries or generators can help avoid black outs.[19] During Hurricane Sandy, solar power systems with attached batteries or generators continued to produce energy while the electric grid was offline, providing hard-hit communities with heat and light during the storm.[20] Solar power also helps prevent blackouts by reducing strain on the grid, and as the electric system evolves, solar panels will be able to provide backup power during power outages caused by storms or other disasters.

Figure 1. Carbon Dioxide Pollution Emitted by the 50 Dirtiest Power Plants Compared to Other Countries, 2011 (MMT CO2)[17]



Drought also creates difficult conditions for cities dependent on fossil fuels or nuclear power. During the Midwest drought of 2012, many fossil-fuel power plants that require cooling water to operate were forced to limit or suspend electricity production.[21] Texas had to divert water away from farmers and ranchers in order to keep lights on at the height of the drought of 2011.[22] Unlike fossil fuel and nuclear power plants that consume vast amounts of water for cooling, solar PV installations consume virtually no water in everyday operation, reducing the strain on water supplies in arid regions of the country and those experiencing drought.[23] This can be a significant benefit in times of drought. The California drought caused a drop in hydroelectricity generation at the beginning of 2014, but the state's solar energy helped to compensate and guard against electricity outages across the state.[24] Climate change will only exacerbate these types of issues and fossil fuel plants could face real limitations as a result.

Solar Energy Is Good for City Residents and the Local Economy

Cities that encourage investments in solar energy offer their residents many important economic and other benefits.

Homeowners and businesses who install solar panels can offset major portions—in some cases all—of their electric bills and see double-digit returns on their investment. Because energy from the sun is free (after the initial investment is made), consumers who invest in solar panels are insulated from the volatile prices of fossil fuel markets. Solar energy can also be a near-term economic winner for consumers and businesses—especially in states where electricity prices are high, owners of solar panels are allowed to recoup the full benefits of the electricity they produce, and there are other strong, pro-solar policies in place.

The benefits of solar energy extend far beyond the home or commercial building where solar panels are installed—solar energy benefits all consumers by reducing many of the costs of operating the electricity system. Among the benefits of distributed solar electricity to the grid are:

- **Reduced need for expensive "peaking" power—**Solar panels usually produce the most electricity on sunny days when demand for power is at its highest. These are the times when utilities must generate or purchase power from expensive, often inefficient "peaking" power plants that may operate only a few hours each year. Expanding solar power can reduce the cost of providing power during these peak periods.[25]
- **Reduced need for investment in transmission capacity—**Similarly, generating more electricity closer to the locations where it is used reduces the need to construct or upgrade expensive transmission capacity.
- **Reduced energy losses—**Many cities depend on electricity transmitted from hundreds of miles away to meet local needs. Roughly 5 to 7 percent of the electricity transmitted over long distance transmission lines is lost.[26] Distributed solar energy avoids these losses by generating electricity at or near the location where it is used.

Solar Energy Creates Jobs

Solar energy also helps the economy by boosting employment. More than 142,000 Americans worked in the solar energy industry as of November 2013, a 20 percent increase from the previous year, and these numbers are expected to grow.[27] In 2013, the number of solar jobs grew 10 times faster than the national average growth in employment.[28] Most of these jobs are in the installation and maintenance of solar panels, while about 20 percent of all solar workers are in manufacturing.[29] Because most solar energy is located onsite, jobs installing and maintaining solar projects are created in the communities where solar panels are sited and cannot be outsourced.

Solar Power Is on the Rise

The amount of solar power in the United States is rising rapidly—reducing America's dependence on dirty sources of energy. America's solar revolution is occurring most dramatically in cities where strong clean energy policies are leading to the rapid adoption of solar energy by homeowners, businesses and electric utilities.

The Promise of Solar Energy Is Increasingly Within Reach

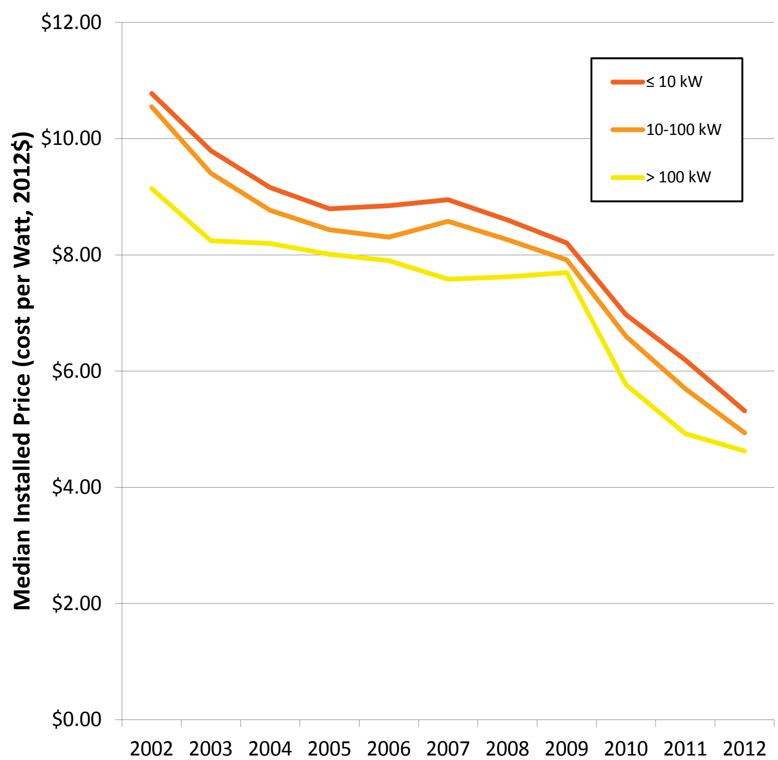
Solar energy is evolving quickly into a mainstream energy source. That evolution has been made possible by a series of innovations that have taken place throughout the solar energy industry and economies of scale that have driven down the cost of solar equipment.

Decades of research have resulted in solar cells that are more efficient than ever at converting sunlight into energy—enabling today's solar energy systems to generate more electricity using the same amount of surface area as those of a decade ago.[30] Researchers continue to discover new ways to make solar panels more efficient at converting sunlight to electricity, which will make solar panels even more powerful tools for electricity generation.[31]

Innovations in manufacturing, the creation of new financing and business models, and improvements in other areas have also helped solar energy become more accessible and less costly over time. An analysis by the National Renewable Energy Laboratory (NREL) shows that large-scale solar manufacturing operations can produce solar equipment at a lower cost, creating opportunities to develop further economies of scale and achieve greater cost reductions.[32]

As a result of these innovations and growing economies of scale, the cost of solar energy has plummeted in recent years and continues to fall. The average cost of solar PV panels less than 10 kilowatts (kW) in size fell by 14 percent between 2011 and 2012, and the cost of solar panels of all sizes continues to drop.[33] (See Figure 2.) In Hawaii, solar energy has already achieved "grid parity"—that is, solar electricity is cheaper than electricity from the grid, even without government incentives.[34]

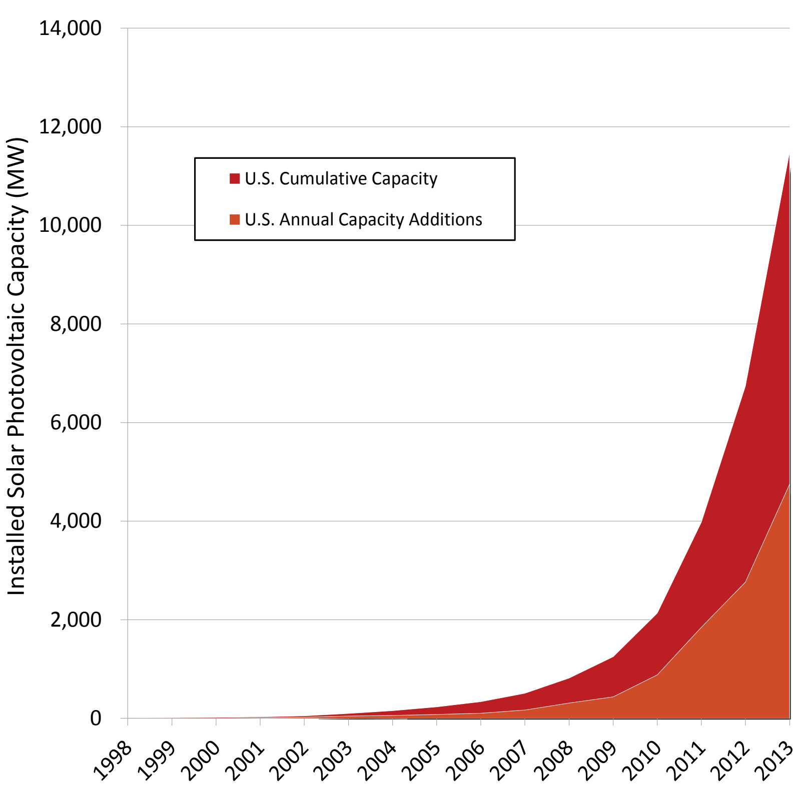
Figure 2. The Median Installed Price of Residential and Commercial Solar Photovoltaic Systems Continues to Fall[35]



Evidence from elsewhere in the world suggests that solar energy prices still have room to fall further. The cost per watt of an installed solar energy system in Germany is roughly half that of the United States due to a variety of factors, including larger average system size, but primarily due to lower "soft costs"—costs such as those associated with attracting customers, installing the systems, completing paperwork, and paying taxes and permitting fees. Installations in Germany had quicker project development timelines and lower overhead.[36] Another recent analysis found that the same set of non-panel related solar project installation costs were nearly four times higher in the U.S. than in Germany, adding an additional 90 cents/watt to the cost of solar installations.[37]

While there are still opportunities to reduce the cost of solar panels, the greatest immediate savings can be achieved by reducing these soft costs.[38] Soft costs in the U.S. have remained relatively consistent—even while panel prices have dropped 60 percent between 2011 and 2013—and can make up to 64 percent of the total cost of an installed solar energy system as of 2013.[39] The U.S. Department of Energy's (DOE) SunShot Initiative, which seeks to lower the cost of installing a solar project to $1 a watt by 2020, is working with the solar industry and other stakeholders in a comprehensive effort to reduce soft costs. If successful, and the DOE recently announced they are 60 percent of the way toward their goal for cost-competitiveness of utility-scale solar projects, solar energy will be even more cost competitive in the years to come.[40]

Figure 3. Annual and Cumulative Installed Photovoltaic (PV) Capacity through 2013, United States[44]



America's Solar Energy Capacity Tripled in Two Years

The year 2013 was a historic year for solar power. The United States passed the 10 gigawatt (GW) mark for solar electric capacity mid-year and installed 4.75 GW of solar PV in 2013 alone, which is the most solar power the United States has ever installed in a single year.[41] (See Figure 3.) The solar power installed in the U.S. in 2013 was worth $13.7 billion and was the second-largest source of new generating capacity in the U.S. that year.[42] The amount of solar PV capacity in the United States tripled between 2011 and 2013 and increased over 200-fold from 12 years ago to the more than 12,000 MW installed by the end of 2013.[43]

A notable portion of America's solar growth is happening in America's cities. Leadership from municipal utilities, solar-friendly city policies and statewide renewable electricity standards are allowing residents, businesses and solar developers to shift urban electricity sources to clean solar power. While still accounting for a relatively small percentage of America's energy needs, the recent phenomenal growth rate of solar power indicates that, with smart public policies, solar energy can continue to emerge as an important source of electricity in America's cities.

America's Top Solar Cities Are Leading the Way

America's cities have made a major contribution to the solar boom. With hundreds of thousands of rooftops that can host solar energy systems, cities have a unique opportunity to be leaders in America's clean energy revolution.

In this report, we review solar photovoltaic (PV) installations in 57 American cities. Each of these cities is within a state that had a substantial amount of installed solar energy capacity (more than 1.5 MW) at the end of 2012.[45] Cities in those states were selected for inclusion in this report if they were:

- The principal city of one of the 50 largest metropolitan areas in the United States, or
- For states with a significant amount of solar capacity but without a city in the 50 largest metropolitan areas nationwide, the state's largest city.[46]

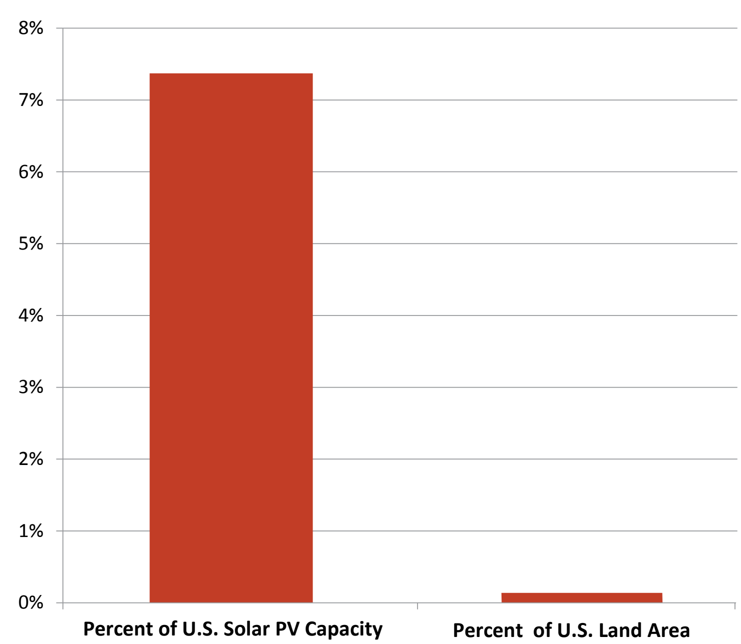
This report represents, to the authors' knowledge, the first national-scale comparison of its kind of solar PV installations in major American cities. There is no uniform national data source that tracks solar energy by municipality, so the data for this report come from a wide variety of sources—municipal and investor-owned utilities, city and state government agencies, operators of regional electric grids, non-profit organizations, and the National Renewable Energy Laboratory's "Open PV" database. (See Methodology.) The use of multiple data sources leads to the possibility of variation among cities in how solar capacity is quantified and in the comprehensiveness of the data. While we endeavored to correct for many of these inconsistencies, readers should be aware that some discrepancies may remain and should interpret the data accordingly.

America's Leading Solar Cities Span the Country

As of the end of 2013, the 57 cities considered in this report had installed 1 gigawatt (GW) of solar PV capacity—more solar PV capacity than existed in the entire United States at the end of 2008.[47] The solar PV capacity installed within these 57 major cities generates more electricity than is consumed in more than 100,000 average U.S. homes in a year.[48]

America's top 20 solar cities—led by Los Angeles, San Diego, Phoenix, San Jose and Honolulu—take up 0.1 percent of the land area of the United States, but account for 7 percent of solar power capacity in the United States.[49]

Figure 4. America's Top 20 Solar Cities as a Percent of U.S. Land Area and U.S. Solar PV Capacity

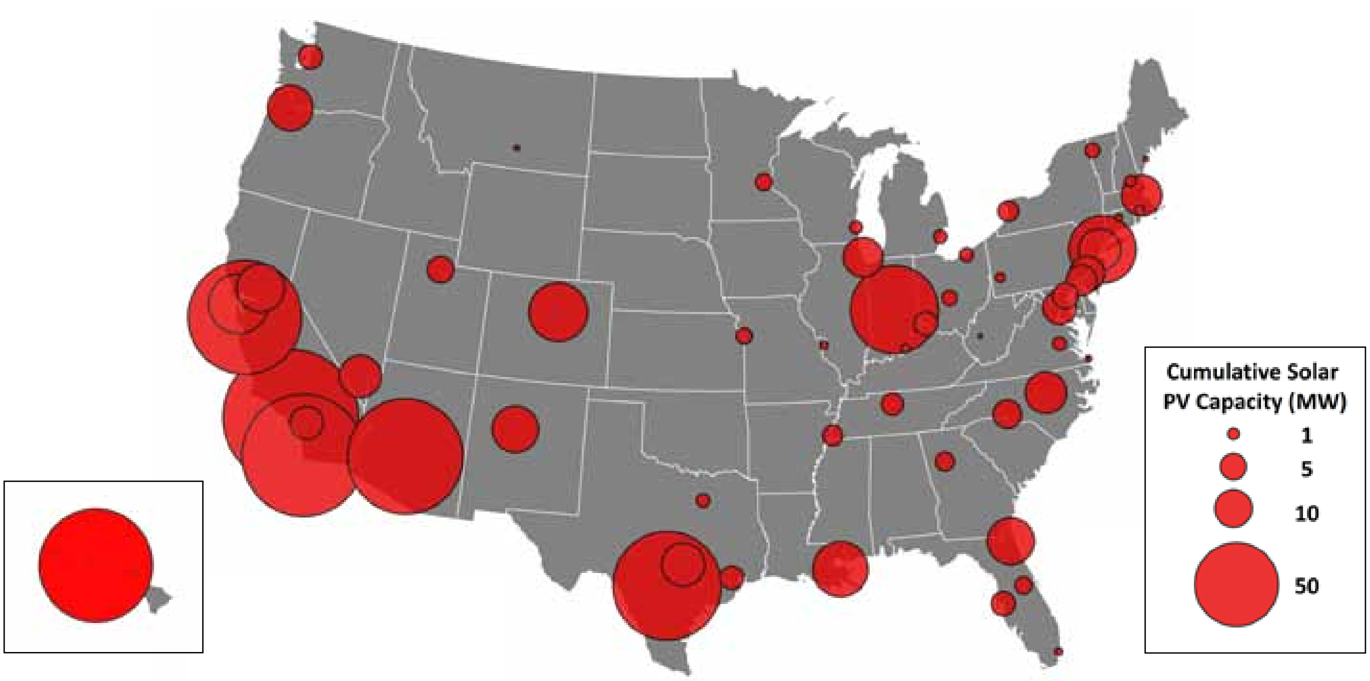


These top 20 cities have a total installed PV capacity of over 890 MW, containing more solar power today than was installed in the entire U.S. just six years ago.[50] These leading cities are located in almost every region of the U.S. (See Table 1 and Figure 5.)

Table 1. Top 20 Solar Cities by Cumulative Installed Solar PV Capacity, End of 2013

Principal City	State	Cumulative Solar PV Capacity (MW)	Cumulative Solar PV Capacity Rank
Los Angeles	CA	132	1
San Diego	CA	107	2
Phoenix	AZ	96	3
San Jose	CA	94	4
Honolulu[51]	HI	91	5
San Antonio	TX	84	6
Indianapolis	IN	56	7
New York	NY	33	8
San Francisco	CA	26	9
Denver	CO	25	10
New Orleans	LA	22	11
Sacramento	CA	16	12
Jacksonville	FL	16	13
Albuquerque	NM	16	14
Portland	OR	15	15
Austin[52]	TX	13	16
Las Vegas	NV	13	17
Newark	NJ	13	18
Raleigh	NC	12	19
Boston	MA	12	20

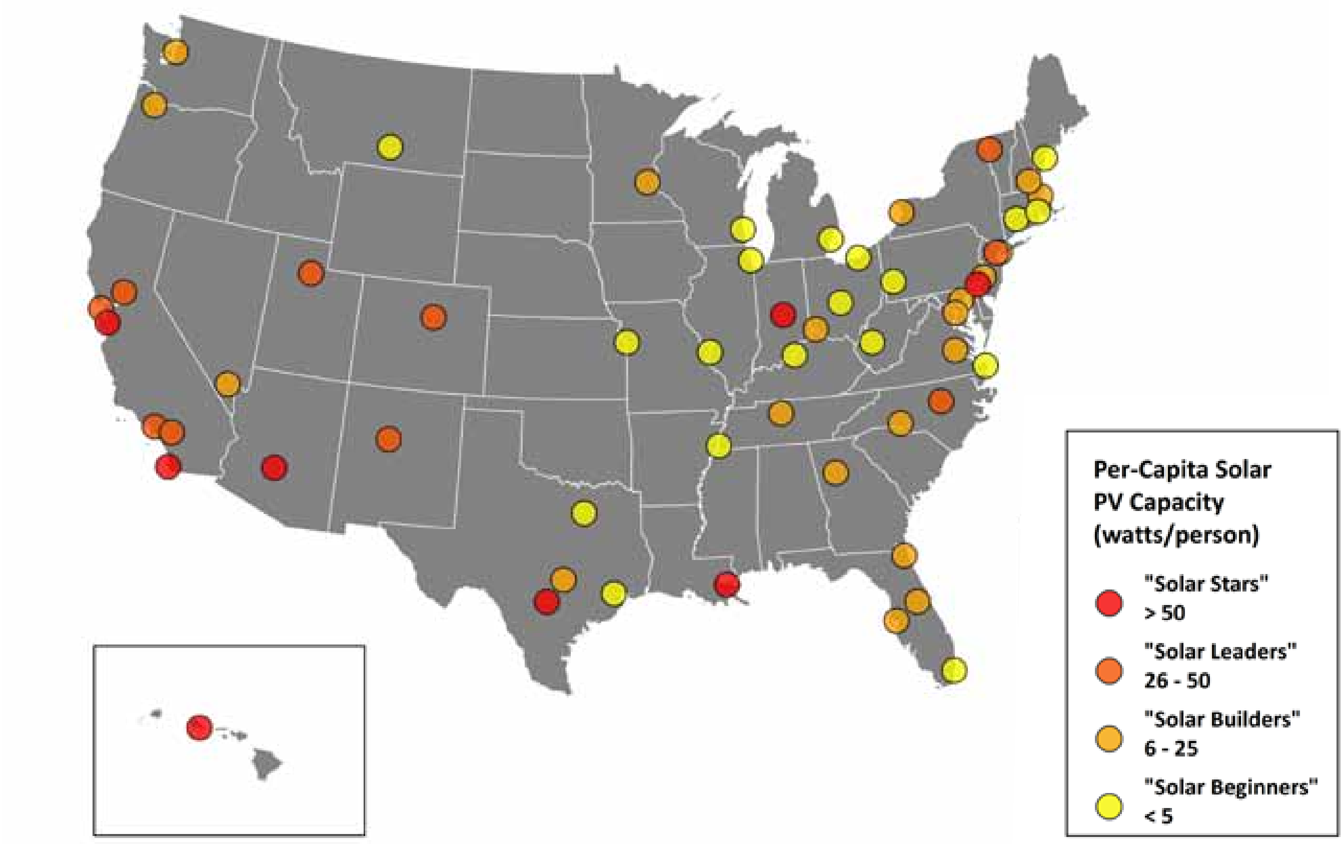
Figure 5. Map of 57 Principal Cities Ranked by Cumulative Installed Solar PV Capacity, End of 2013



On a per-capita basis, Honolulu is the leading solar city, followed by San Jose and Wilmington, Delaware. (See Figure 6 and Table 2.)

By comparing solar capacity per-capita, one can group the cities into several categories.

Figure 6. Map of 57 Principal Cities Ranked by Installed Solar PV Capacity per Person, End of 2013



Stars

Solar Stars are cities with more than 50 watts of installed solar PV capacity per person. They are cities that have experienced dramatic growth in solar energy in recent years and are setting the pace nationally for solar energy development.

Table 2. The "Solar Stars" (Cities with More Than 50 Watts of Installed Solar PV Capacity per Person, End of 2013)

Principal City	State	Cumulative Solar PV Capacity (MW)	Solar PV Capacity per Capita (Watts/Person)	Solar PV Capacity per Capita Rank
Honolulu	HI	91	265	1
San Jose	CA	94	97	2
Wilmington	DE	7	96	3
San Diego	CA	107	81	4
Indianapolis	IN	56	68	5
Phoenix	AZ	96	65	6
San Antonio	TX	84	62	7
New Orleans	LA	22	60	8

Leaders

Solar Leaders are cities that have more than 25 and less than 50 watts per person. These cities include several of those (such as Los Angeles, San Francisco and Denver) that lead the nation for total solar capacity.

Table 3. The "Solar Leaders" (Cities with Between 25 and 50 Watts of Installed Solar PV Capacity per Person, End of 2013)

Principal City	State	Cumulative Solar PV Capacity (MW)	Solar PV Capacity per Capita (Watts/ Person)	Solar PV Capacity per Capita Rank
Newark	NJ	13	46	9
Denver	CO	25	40	10
Burlington	VT	2	37	11
Sacramento	CA	16	35	12
Los Angeles	CA	132	34	13
San Francisco	CA	26	31	14
Raleigh	NC	12	30	15
Albuquerque	NM	16	28	16
Salt Lake City	UT	5	27	17
Riverside	CA	8	26	18

Builders

The Solar Builders are those with at least 5 and no more than 25 watts of solar PV capacity per person. This diverse group of cities includes cities that have a history of solar energy leadership as well as cities that have only recently experienced significant solar energy development.

Table 4. The "Solar Builders" (Cities with Between 5 and 25 Watts of Installed Solar PV Capacity per Person, End of 2013)

Principal City	State	Cumulative Solar PV Capacity (MW)	Solar PV Capacity per Capita (Watts/ Person)	Solar PV Capacity per Capita Rank
Portland	OR	15	24.8	19
Las Vegas	NV	13	22	20
Jacksonville	FL	16	19	21
Boston	MA	12	19	22
Austin	TX	13	16	23
Cincinnati	OH	4	14	24
Washington	DC	8	13	25
Tampa	FL	4	12	26
Buffalo	NY	3	12	27
Manchester	NH	1	9	28
Orlando	FL	2	9	29
Charlotte	NC	6	8	30
Baltimore	MD	5	8	31
Seattle	WA	4	7	32
Richmond	VA	1	6	33
Atlanta	GA	3	6	34
Philadelphia	PA	9	6	35
Nashville	TN	4	6	36
Minneapolis	MN	2	5	37

Beginners

The Solar Beginners include cities with less than 5 watts of installed solar PV capacity per person. Many of these cities are just beginning to experience significant development of solar energy, while a few have experienced little solar energy development at all. New York, with its preponderance of high-rise buildings and more people than many states, has a lower per-capita ranking, but ranks seventh in the nation for total solar capacity and has experienced substantial growth in solar energy in recent years.

Table 5. The "Solar Beginners" (Cities with Less Than 5 Watts of Installed Solar PV Capacity per Person, End of 2013)

Principal City	State	Cumulative Solar PV Capacity (MW)	Solar PV Capacity per Capita (Watts/ Person)	Solar PV Capacity per Capita Rank
Memphis	TN	3	4.6	38
Providence	RI	1	4	39
Chicago	IL	11	4	40
New York	NY	33	4	41
Kansas City	MO	2	4	42
Cleveland	OH	1	4	43
Portland	ME	< 1	3	44
Hartford	CT	< 1	3	45
Charleston	WV	< 1	3	46
Pittsburgh	PA	1	2	47
Milwaukee	WI	1	2	48
Columbus	OH	2	2	49
Billings	MT	< 1	2	50
Detroit	MI	1	2	51
Houston	TX	4	2	52
St. Louis	MO	< 1	1	53
Dallas	TX	1	1	54
Miami	FL	< 1	1	55
Louisville	KY	1	1	56
Virginia Beach	VA	< 1	1	57

Little Cities That Could: Lancaster, Sebastopol, Gainesville and New Bedford Drive Solar Power with Strong Policies

We focus on 57 major cities in this report, but smaller cities have taken noteworthy steps to promote the growth of solar power.

Lancaster and Sebastopol, California

Two California cities—Lancaster and Sebastopol—have adopted requirements that all newly built and renovated homes and commercial buildings incorporate solar energy.[53] These cities were the first in the country to enact such a requirement, and these forward-looking policies were driven by determined local officials. The Sebastopol City Council unanimously voted to pass the policy, which requires 2 watts of solar power per square foot for new buildings, or enough solar power to offset 75 percent of the building's annual electricity usage.[54]

Lancaster City Council passed a similar law requiring every new housing development to install an average of 1 kilowatt (kW) of solar power per home.[55] According to Lancaster Mayor Rex Parris, 26 percent of the city's electrical needs were met with solar power as of January 2014.[56] This includes 7.5 MW of solar power installed on 25 schools and 8 MW of solar power installed at Lancaster High School and Antelope Valley College.[57] Lancaster's program to buy solar power back from schools will save these schools $43 million in energy bills over the next 25 years.[58] Lancaster is creating a model for other cities to follow according to Mayor Parris, who said, as quoted by *The Planning Report*: "The goal is to create a template for other cities. Ultimately the world is going to wake up and realize that climate change threatens the very existence of the species. Once people wake up to that fact, they'll want a template set—so this is what you do to do your part. Each city can do this to lower their carbon footprint."[59]

Gainesville, Florida

Officials in Gainesville, Florida, have implemented several effective policies making solar energy more accessible to its citizens. The most prominent program contributing to Gainesville's solar success was the city's feed-in tariff (FiT) for solar photovoltaic systems, which was offered until the end of 2013.[60]

The city was first in the nation to introduce per-kilowatt hour incentive payments for solar power. The city's municipal utility, Gainesville Regional Utilities (GRU), provided predetermined rate payments to owners of qualified residential and commercial photovoltaic (PV) systems based on the amount of electricity they generated. In March 2014, GRU's total solar capacity reached 18 MW from its FiT program and 2 MW from net metering, for a total of 20 MW of installed solar capacity in GRU's service area.[61] While Gainesville accounts for only 0.7 percent of Florida's population, the service area of the Gainesville utility (which includes some outlying areas around Gainesville) accounted for 9 percent of the state's total installed solar energy capacity at the end of 2013.[62] Gainesville is no longer offering the FiT in 2014 but will continue to offer net metering to its customers; this means Gainesville solar producers can no longer receive above-retail rate FiT payments for solar power production but will receive credit for the electricity they deliver to the electric grid through net metering.[63]

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New Bedford, Massachusetts

New Bedford is a powerful example of smart solar policies at work. The city has faced high levels of poverty and low average incomes, but, despite these challenges, the city has adopted aggressive local policies to promote renewable energy and energy efficiency and reduce its electricity spending. Scott Durkee, director of the New Bedford Energy Office, said that the city's ability to spur solar energy despite economic troubles shows that any city can "go solar."[64]

New Bedford created its Energy Office in 2010 and set a goal of installing 10 MW of solar power in the city within five years. The city is currently on track to hit that goal more than a year early.[65] Currently, 5.2 MW of solar power are installed within the city, with 7 MW set to come online in areas in and around the city by the summer of 2014.[66] New Bedford also offers a "Clean Energy Results" program to promote solar farms on unusable "brownfields," or environmentally contaminated land, thereby creating a sustainable energy source from an otherwise unusable area.[67] New Bedford has contracted with Con Edison Solutions and Blue Wave Capital to construct a solar farm on a brownfield site adjacent to a middle school and high school, which is helping teachers at these schools develop clean energy curricula and connect students to jobs in the solar industry. New Bedford's public buildings with solar installations include three schools, a public gym and their Department of Public Infrastructure Building.[68] The city of New Bedford signed a power purchase agreement with Con Edison Solutions, the firm that will own the solar projects, to purchase all the solar power generated by these installations.[69]

The Massachusetts State Energy Office recognized New Bedford with a "Leading by Example Award" in 2013, as a city that has "established and implemented policies and programs resulting in significant and demonstrable energy and environmental benefits."[70]

Smart Policies Have Fueled Growth in America's Top Solar Cities

Those cities that have opened the door for solar energy with the adoption of strong, smart public policies are building the nation's most successful solar markets, not necessarily the cities that receive the most sunlight. Cities where homeowners are paid a fair price for the energy they supply to the grid, where installing solar panels is easy and hassle-free, where there are attractive options for solar financing, and where there has been a strong commitment to support solar energy development, are seeing explosive growth in solar power.

Top solar cities have followed a variety of paths in developing solar energy. In some cases, city governments have played an important role in jump-starting local solar growth by setting goals for installed solar capacity, implementing solar-friendly laws, and welcoming solar businesses. Cities with municipal utilities have had an even more direct influence on solar power adoption by establishing ambitious requirements for solar energy and implementing effective financial incentives. Some cities have taken steps to increase the use of solar energy on public facilities, while, in other cities, strong state policies are driving local solar power growth.

Cities can most effectively promote solar power when city, state and utility policies work together. This section will describe policies and practices that have encouraged solar power growth in leading solar cities.

City Policies Set an Example and Encourage Solar Growth

Local governments have a special role in fostering the growth of solar energy. City governments can promote solar power by streamlining the permitting and installation process, offering financial management options, and installing solar power on city property. By establishing pro-solar policies, cities can create local installation and manufacturing economies of scale that drive solar development.

City Governments Lead by Example

Many government buildings—from schools to libraries to government offices—are excellent candidates for solar energy. Installing solar power on city buildings can model environmentally responsible behavior and demonstrate city leadership with the adoption of technologies that benefit residents.

Leading solar cities, including Denver and Portland, are driving solar power growth starting with their public buildings. Denver has installed 9.4 MW of solar power on city and county buildings, and the city has partnered with the Denver Public Schools to install solar power on 28 school buildings.[71] To encourage community participation and support for city solar power, Portland has also launched "Solar Forward," an initiative that asks community members to chip in to fund city solar projects.[72]

Cities Streamline Solar Permitting and Protect Residents' "Solar Rights"

Helping reduce the "soft costs" of installing solar PV is a crucial step in making a community hospitable to solar power. Some of the most significant expenses and hurdles faced by potential solar power installers are fees for permitting, inspection and interconnection.[73] Local governments can play an important role in preparing the way for solar energy through the adoption of smart permitting and zoning rules that eliminate unnecessary obstacles to solar development. Local building codes can also help spark the widespread adoption of solar energy, either by requiring new homes and businesses to be "solar-ready" or by requiring the use of small-scale renewable energy in new or renovated buildings.

Leading solar cities have taken significant steps to streamline the permitting and installation process for solar power.

- Chicago's "Green Permit Program" allows solar PV projects to receive permits in less than 30 days.[74] The cities of Portland and San Francisco have also streamlined the permitting process by reducing wait times for solar PV applications and creating online permitting tools.[75]
- San Jose and Philadelphia have reduced permitting fees and streamlined the application process for solar PV installations. In San Jose, the solar permit application is only one page long, and, in Philadelphia, solar permitting fees are reduced to include only the cost of labor, not labor and equipment costs.[76]

In addition to adopting solar-friendly zoning ordinances and streamlining permitting requirements for solar PV systems, local governments can also adopt "solar rights policies," which protect access to solar power by overriding local ordinances or homeowners' association policies that bar residents from installing solar power equipment on their properties. Cities including Austin have passed laws to allow solar installations to exceed height restrictions stated in the city zoning code.[77] Solar rights policies have also been passed at the state level to stop homeowners' associations from interfering with the installation of solar panels; states that have passed such policies include Hawaii, New Jersey, Virginia and Texas.[78]

As highlighted in the introduction, collective purchasing programs can also drive solar power in cities. "Solarize" programs streamline the process of purchasing solar power and can bring down the cost for solar installers and consumers installing solar panels. Portland, Oregon was the first to offer this program, and city and state programs—like Solarize Boston, Solarize Massachusetts and Solarize Connecticut—have followed suit.[79]

Financing Options Make Solar Power Viable

Often, the biggest hurdle standing in the way of solar energy adoption is not the total cost, but rather the up-front cost of solar power, the amount due at the time of installation. For many homeowners and small businesses, the prospect of buying 20 years' worth of electricity up-front is daunting—particularly if there is a chance that one might move during that time. Creative financing options at the local level can help home and business owners manage the expenses associated with installing solar power.[88]

Local governments can partner with local lending institutions to provide solar financing options that help community members manage the up-front cost of solar power. City governments can facilitate this process by educating the public on solar PV financing options and offering Solarize programs that connect community members directly with lending programs.[89] In Milwaukee, the city "Milwaukee Shines" program partnered with Summit Credit Union to offer low-interest loans of up to $20,000 for eligible solar PV installations. Austin has partnered with Velocity Credit Union to provide a solar loan program that can lend customers up to $20,000.[90]

Cities can also offer tax breaks for solar power. New York City offers a property tax credit for homeowners who install solar panels and exempts residential solar panels from sales tax.[91] Ohio cities Cleveland and Cincinnati offer property tax abatements for buildings that are certified as "green," including many that incorporate solar energy.[92]

Commercial PACE Programs Help Communities Finance Solar Power

Property Assessed Clean Energy (PACE) financing is a tool that cities can use to make solar power affordable. PACE programs can be established and run directly by a local government, or sponsored locally and administered by an outside third-party organization. PACE financing allows property owners to borrow money from a specially created fund for clean energy projects. The loan is paid off on property tax bills over a number of years, thus, future repayment of the loan is assured, even if the property changes hands.[93]

Communities are beginning to make commercial PACE programs a reality. Connecticut has launched a statewide commercial PACE program, managed by the Clean Energy Finance and Investment Authority and endorsed by the Connecticut Bankers Association.[94] This program has given commercial property owners loans to install onsite renewable energy or undergo energy efficiency upgrades, and enabled them to pay back these loans over a number of years on their property taxes.[95] South Florida communities have also taken steps to create a financing district for commercial PACE. Cities including Miami and Coral Gables have joined the "Green Corridor District," where a PACE program backed by Lockheed Martin, Barclays Capital and Ygrene Energy Fund is slated to fund $550 million in energy retrofits, which can include solar installations.[96]

Residential PACE programs have the same potential to unlock investments in solar energy and energy efficiency improvements. Unlike commercial PACE programs, however, residential PACE programs are largely on hold due to opposition from the Federal Housing Finance Agency and the mortgage lenders Fannie Mae and Freddie Mac.[97]

Cities Can Partner with Utilities to Drive Solar Development

City governments with control over their electric utilities are able to implement policies that directly encourage solar power growth, and, with a large percentage of utility customers, cities can use their negotiating power to influence the investor-owned utilities that serve them. Cities with municipal utilities, including Los Angeles, Austin, San Antonio and Jacksonville (along with New Orleans, which has regulatory authority over its investor-owned utility) have taken strong action to promote local solar power. New York City has also effectively partnered with Con Edison, an investor-owned utility, to promote local solar power.

Los Angeles Establishes a Feed-In Tariff

Municipal utilities may set up a feed-in tariff (FiT), which gives energy producers a fixed and long-term contract for the solar electricity produced. These are also known as CLEAN (Clean Local Energy Available Now) contracts, and their effectiveness depends on a number of factors including how quickly customers can get a return on their investment in solar power.

The Los Angeles Department of Water and Power launched the nation's largest FiT program in July 2013, which will bring 100 MW of solar power online.[98] This program will help the Los Angeles Department of Water and Power meet its state-mandated requirement of generating 33 percent of its energy

America's Leading Solar Cities Are Bringing the Benefits of Solar Power to Residents

Solar power offers an array of environmental, public health and economic benefits for cities—benefits that some of the nation's leading solar cities are working to realize.

Since Hurricane Katrina, New Orleans has been a symbol of the disastrous impacts of extreme weather events. As a "Solar Star" city, New Orleans is doing its part to help mitigate the adverse impacts of global warming by generating more electricity with solar power and less with fossil-fueled energy sources. The solar PV capacity installed in New Orleans at the end of 2013 can produce more energy than 2,500 average homes consume in a year, and this is clearly just a start in a city of 370,000 people.[80]

Credit: Gulf South Solar

A rooftop solar installation generates clean energy in New Orleans.

In cities vulnerable to drought or prone to water shortages, solar power is also a water-saver. In drought-stricken Texas, for example, San Antonio and Austin are avoiding millions of gallons of water waste by transitioning to solar power.[81] In California, where more than 90 percent of the state was experiencing severe to exceptional drought conditions as of February 2014, solar PV capacity in California cities will be an important energy solution in a state that cannot needlessly waste water on electricity generation.[82]

Solar power can also save city governments money. In Neptune Beach, Florida, right outside the city of Jacksonville, energy bills for city hall have been dropping rapidly thanks to the 140 solar panels that have been installed on top of the city building. Harnessing solar energy has reduced electricity costs for the Neptune Beach city hall by $7,300 in 2013, as compared to 2012.[83] Like Neptune Beach, Jacksonville encourages sustainable city buildings; it established a "Sustainable Building Program" in 2009 that required all new city buildings to meet green building certification standards, which can include solar panel installations on buildings.[84]

Cities and states that install a significant amount of solar power are attracting solar jobs. Los Angeles's "100 MW Feed-in Tariff" program is expected to create more than 2,000 local jobs within the city.[85] As California leads the country in solar capacity, it is also home to the largest number of solar jobs in the country, with more than 47,000 statewide jobs in solar installation and solar manufacturing.[86] A study of Colorado's solar industry also revealed statewide economic benefits. Since 2007, the Colorado solar industry has created the equivalent of 10,790 full-time jobs, and solar employees have amassed over $500 million in earnings.[87]

Indianapolis Goes Solar: Indianapolis Power & Light Creates a Feed-In Tariff Program

In 2012, Indiana had only a little over 4 MW of solar capacity installed in the entire state—one 600th the amount installed in California and only about 2 percent as much as was installed in Massachusetts.[102] But Indianapolis Power & Light's feed-in tariff program changed the picture for solar energy in Indianapolis.

In 2010, Indianapolis Power and Light (IP&L) took the first step toward diversifying its energy sources, which largely consisted of coal at the time, by instituting a voluntary feed-in tariff program.[103] This program pays solar power producers fixed, above-market rates for solar power generated. Once this program was running, Indianapolis became an attractive place for solar developers to generate power. In 2013, a 12 MW solar installation came online at the Indianapolis airport and three utility-scale installations—over 25 MW in capacity—came online, with the power sold to IP&L.[104] Over 59 MW of additional solar PV is in development in Indianapolis as of the beginning of 2014—which will bring the city's solar PV capacity to 98 MW.[105]

IP&L's FiT was discontinued in March 2013, which may mean slower solar power growth going forward.[106] IP&L continues to offer net metering and a small-scale solar PV incentive program that provides rebates for qualifying residential solar installations.[107] For Indianapolis, solar energy has meant reduced reliance on polluting coal-fired power plants, valuable new investments in the city, and jobs created through construction of these large scale solar projects.[108]

Photo: Dominion

The "Indy I" Solar Array depicted is one of three utility-scale solar projects owned by Dominion Energy Resources—these projects represent a combined 28.6 MW of solar power in Indianapolis.

Photo: Solar San Antonio

A solar energy system installed on the roof of a house in San Antonio with the help of CPS Energy.

with renewable sources by 2020.[99] It is projected to create more than 2,000 jobs and generate $300 million of investment in Los Angeles.[100] A University of California Los Angeles report from February 2014 shows that the first 100-MW component of the FiT is on target to meet its capacity and solar jobs goals.[101]

San Antonio and Austin Set Solar Goals and Offer Incentive Programs

In Texas, the cities of San Antonio and Austin have led solar development through their respective municipal utilities, Austin Energy and CPS Energy. Both utilities have set high goals for solar power adoption. CPS Energy has adopted a goal of using renewable energy to meet 20 percent of its electricity demand by 2020, with at least 100 MW of energy derived from non-wind renewable sources.[109] The city of Austin enacted a renewable electricity standard in 2011 that requires its municipal utility, Austin Energy, to get 35 percent of its energy from renewable sources by 2020, including 200 MW from solar power.[110]

With these goals to drive them, CPS Energy and Austin Energy have offered an array of solar financing options and incentives from which residents can choose. To help residential customers overcome the up-front costs of installing solar power, Austin Energy offers a solar rebate program that pays qualifying customers $1,250 per kilowatt of solar PV capacity installed and has partnered with Velocity Credit Union to provide a solar loan program that can lend customers up to $20,000.[111] CPS Energy also offers a solar PV rebate program, with tiered incentives for residential, school and commercial installations and extra funding for those customers that use local solar installers.[112] Austin Energy also offers a performance-based incentive for commercial and multi-family installations; this is a payment from the utility to the commercial or multi-family customer per kilowatt-hour of solar power produced for up to 10 years.[113]

Austin Energy is offering a "value-of-solar" tariff in place of net metering, and CPS Energy is considering the same transition. Austin Energy's value of solar tariff sets a fixed rate each year at which the

Photo: NW Wind & Solar

A community solar project atop the Seattle City Aquarium.

utility will credit customers for the solar power they generate—this rate is based on energy savings and environmental benefits that are meant to quantify the value of solar power to the electricity grid and compensate solar producers accordingly.[114] While the tariff does provide compensation to owners of solar energy systems, it lacks the long-term predictability of net metering and is unlikely to capture the environmental benefits of solar power.[115]

At the end of 2012, solar power in the city limits of San Antonio and Austin accounted for over 44 percent of all utility-supported solar power in Texas.[116]

Seattle City Light Supports Community Solar Gardens

Community solar programs make solar power a viable option for every resident in a utility's service territory. These programs work when utilities allow their customers to fund ideally-situated community solar projects that are not necessarily connected to every customer; customers funding the project then receive credit for the output of the solar project on their utility bills.[117] Community solar, which may offer ratepayers lower upfront costs, economies of scale and more optimally sited facilities, are an attractive alternative for homeowners or renters who cannot site solar on their residences.

Seattle City Light allows their customers to invest in community solar projects that are not located on their properties but whose output is still credited on their utility bill. The utility's community solar program recently funded an installation on the Seattle Aquarium.[118]

Jacksonville Electric Authority Supports a 15 MW Solar PV Facility

Jacksonville Electric Authority (JEA), the municipal electric utility serving Jacksonville, Florida, has taken action to get more power from clean energy sources. JEA signed an agreement in 2010 to buy all solar power from a 15 MW solar power facility in Jacksonville for 30 years, thereby avoiding 22,430 tons of global warming pollution each year and bringing online enough energy to power 1,400 homes annually.[119] At the time, this was the largest solar PV facility in northern Florida, and it created 70-75 direct jobs for Floridians.[120] This large solar project is an important start toward cleaning up Jacksonville's energy sources; by encouraging more onsite solar on city buildings, JEA can bring more benefits to the city's citizens and businesses. JEA also offers net metering to its customers, which helps to incentivize rooftop solar power development in the city.[121]

New York City and Con Edison Create Solar Power in the Big Apple

In New York City, partnership with Con Edison, the investor-owned utility serving the city, was a key driver of the pro-solar policies that helped solar power take off in the city. In 2007, New York City was designated a "Solar America City" by the U.S. Depart-

New Orleans Goes Solar: State and Local Policies Work Together to Rebuild a Clean Energy Community

New Orleans is a national leader in installed solar power thanks to strong city regulations.

New Orleans had no solar power capacity in 2007, and less than 1 MW was installed by the end of 2010.[122] Today, however, the city is ranked eleventh on our list of cities for total installed solar PV capacity and has the eighth most installed solar PV capacity per person of the 57 major cities we analyzed. New Orleans is emerging as one of the nation's leading solar cities thanks in large part to the actions of local officials in regulating the city's electric utility, Entergy New Orleans.

With the help of a Solar America Cities grant, city government action brought solar power to New Orleans. The utility serving New Orleans, Entergy New Orleans, is an investor-owned utility regulated by the city of New Orleans.[123] The city of New Orleans worked with Entergy to streamline the application process for solar panels, reducing the application length from 50 pages to two pages. In 2007, the city also required Entergy to offer net metering to its customers, standards that would ensure small renewable energy generators receive full, fair credit for the excess energy they deliver back to the utility grid.[124] After Hurricane Katrina devastated the city, government funds also helped rebuild some communities, like the St. Thomas Housing Project, in a sustainable manner; the solar arrays on the rooftops of this revitalized area save residents about $50 per month on utility bills.[125]

State policies also combined with these city initiatives to help make New Orleans an attractive place for solar power. In 2007, Louisiana passed legislation creating statewide solar tax incentives. Two years later, legislation passed that allowed third parties to own residential renewable energy credits and allowed for the creation of renewable energy financing districts.[126] Louisiana has no renewable energy standard, however, making New Orleans' actions at the city level particularly important to drive local solar development.

The city of New Orleans now has almost three times as much solar power as was present in Mississippi, Alabama, South Carolina and Arkansas combined at the end of 2012.[127]

ment of Energy (DOE), helping to kick off a collaboration between the City University of New York, Con Edison, the New York City Department of Builders, the New York State Energy Research and Development Authority (NYSERDA) and the DOE's Solar America Cities program.[128] This collaboration proved fruitful—from 1 MW of installed solar PV capacity in 2007, New York City met its Solar America Cities goal of 8.1 MW in mid-2012, three years ahead of schedule.[129]

Effective partnership with Con Edison was a significant contributor to this success. Con Edison introduced a new net metering policy in 2009 that allowed more solar installations to connect to the grid and receive credit for the excess energy they fed back into it.[130] In 2010, Con Edison also worked with NYSERDA and city agencies to launch the "100 Days of Solar" initiative to streamline the process of issuing a solar permit, interconnecting customers to the grid, and issuing them a rebate.[131] That year, Con Edison also developed "solar empowerment zones" through its partnership with the city and other stakeholders; these are geographic regions in the city identified to be ideal for solar power production, in which solar projects are eligible for additional solar incentives.[132] The collaboration between Con Edison and NYC solar stakeholders has helped bring New York City into the top 10 cities for cumulative installed solar PV.

Strong State Policies Enable the Creation of Solar Cities

State-level policies to promote solar energy have been critical to building successful solar energy markets in several of America's cities. States can set statewide solar energy requirements and establish standardized incentive programs to help residents finance solar projects. As the nation's primary regulators of electric utilities, state governments have a critical role to play in ensuring that interconnection rules and net metering policies are clear and fair and that utilities are considering renewable energy technologies such as solar power in their own resource investment decisions.

In addition, as solar power comes to supply an increasing share of the nation's energy supply, state governments will need to be at the forefront of designing policies that transition the nation from a power grid reliant on large, centralized power plants to a "smart" grid where electricity is produced at thousands of locations and shared across an increasingly nimble and sophisticated infrastructure. The development of policies that allow for the integration of high percentages of solar energy in the electric grid will present the next challenge to the growth of solar energy.

Statewide Renewable Energy Standards with a Meaningful Solar Carve-Out

Setting specific, statewide requirements for the adoption of solar power can create an attractive environment for solar investments in a given state, including in its major cities.

New Jersey and Delaware

New Jersey and Delaware have among the strongest solar-specific renewable electricity standards (RES) in the country.[133] New Jersey's standard aims to have solar energy provide 4.1 percent of the state's electricity use by 2028, and Delaware's standard is ramping up to get 3.5 percent of its utilities' electricity supply from solar PV by 2026.[134] These strong policies have made these states—and the cities of Newark, New Jersey and Wilmington, Delaware—national solar leaders. Wilmington ranked third out of the 57 cities we surveyed for per-capita solar PV capacity with 96 watts installed per person, and Newark ranks among the "Solar Leaders." Wilmington boasts more solar power capacity than Houston, Texas, which is 55 times its size.[135]

Massachusetts

In Massachusetts, a strong renewable energy standard is paired with state government policies to make solar power an attractive investment. These policies have helped to bolster Boston's city-level programs.

Massachusetts requires that investor-owned utilities and retail electric suppliers generate 21.1 percent of their power from renewable energy sources by 2020, including 1,600 MW of solar power.[136] Utilities demonstrate compliance with the solar power requirement by purchasing solar renewable energy credits (SRECs). These SRECs are accumulated by owners of solar panels for every megawatt-hour (MWh) of power those panels produce. To ensure that those investments retain their value, the state has established an auction mechanism with a floor price.[137]

Massachusetts also offers solar rebates to residents and businesses through its "Commonwealth Solar II" program. This is a rebate program that provides money back to approved residential, commercial and industrial solar projects.[138] In addition to these incentives, qualifying solar power installations can be exempt from sales and property taxes for 20 years in Massachusetts, and Massachusetts offers net metering and interconnection policies that make it easier for small generators to connect to the grid.[139]

These policies combine to support solar power development in Boston—putting it in the top 20 cities for total installed solar PV capacity and ranking it 22nd of the 57 cities reviewed in this report for per-capita solar PV capacity.

Net Metering and Interconnection Standards

Most small solar generators do not use all of the electricity that their solar panels generate. In order to make solar power an affordable option, small clean energy producers must be able to get credit for the excess power that they return to the utility grid. Net metering allows utility customers who install solar panels to be treated fairly for the excess electricity they provide to the grid, only charging them for their net electricity usage. The best net metering policies allow customers to get credit for excess electricity they send back to the grid at the same retail rate at which they purchased electricity from their utility. The most solar-friendly states have established requirements for net metering that apply to all utilities; this ensures that solar power producers are not charged unfair fees when benefiting from the energy they produce.

Weakening Net Metering Regulations Could Jeopardize Solar Power Growth in Cities

The growth of solar power is empowering residents and businesses to look beyond the dirty energy alternatives of the past. Yet some utilities, as more and more of their customers generate their own electricity, have begun to see solar energy as a threat to their business model. As a result, some utilities have begun to attack net metering policies designed to help solar power generators recoup the cost of their solar installations.

Arizona, for example, was recently the site of such a battle between Arizona Public Service Company (APS) (one of the utilities that serve Phoenix) and Arizona solar power net metering customers. APS campaigned to charge solar power generators a large fee. Following an outpouring of opposition from the public to APS's proposal, the Arizona Corporation Commission approved a small fee, and otherwise net metering remained unchanged.[140] Net metering has helped Phoenix rank third on our list for cumulative solar PV capacity and sixth for watts of solar power installed per person.

Net metering is an essential policy for encouraging distributed solar power on residential rooftops. It is an important protection for solar producers who are using a beneficial technology to reduce their electricity bills; solar producers should receive the full benefits of power production and utilities should not be able to penalize customers for generating clean energy. Utility attacks on strong net metering policies will only unfairly prevent viable homes and otherwise eager residents from taking part in the solar revolution.

It is also important for states to have clear interconnection standards that do not impose additional expenses on people wishing to install solar power. Interconnection standards clarify how and under what conditions utilities must connect solar panels to the grid while preserving the reliability and safety of the electricity system. Good interconnection policies reduce the time and hassle required for individuals and companies to connect solar energy systems to the grid. California, Massachusetts, New Mexico, Oregon, Utah and Virginia have received an "A" grade for their net metering and interconnection policies from the Vote Solar Initiative and Interstate Renewable Energy Council's joint "Freeing the Grid" assessment, meaning these states have regulations in place that make it easier and more economical for customers to connect their rooftop solar panels to the grid.[141]

"Virtual net metering" is another important state policy to encourage solar power in apartments and multi-tenant housing facilities. Once states approve this policy, electricity customers in apartment buildings or multi-tenant homes can share the benefits of a rooftop solar installation, even if their meters are not directly connected to the solar project. Credits from solar power produced at one location can offset energy bills at another location. Currently, virtual net metering is available in eleven states, including Minnesota and D.C., which passed virtual net metering policies in 2013.[142]

Statewide Solar Energy Rebate Programs

Like cities, states can offer incentive programs that reduce the upfront cost of solar PV installations. Hawaii, California, New York and Massachusetts offer successful statewide programs that have helped residents take advantage of solar power. While rebates were essential for incentivizing new solar markets in years past, now they are expanding to make solar power accessible to low income communities and other underserved sectors.

Hawaii

Hawaii has the highest rates of solar PV grid penetration in the country, likely due to high electricity prices on the

Photo: Hawaiian Electric Company

Solar panels on the roof of the non-profit Easter Seals Society building with downtown Honolulu in the background.

islands, the falling costs of solar equipment and the state's strong renewable energy goals.[143] Hawaii has one of the strongest renewable energy standards in the country, with a requirement of meeting 40 percent of its energy needs with renewables by 2030. In 2008, it formed the "Hawaii Clean Energy Initiative"—a partnership between the State of Hawaii and the U.S. Department of Energy—to help meet this goal.[144]

Hawaii has taken other steps to bring more renewable energy to the state. In 2013, the Hawaii Legislature adopted a measure that enables "on-bill financing" for solar energy and other forms of clean energy technology.[145] On-bill financing allows customers to pay for solar projects over time on their utility bills. Hawaii also offers a statewide feed-in tariff that credits small solar power producers with 21.8 cents per kilowatt-hour of energy generated, with slightly lower rates available for solar PV projects more than 20 kW but less than 5 MW.[146] Hawaii continues to grapple with the challenge of transitioning the small islands' electric grids to accommodate more rooftop solar generation, but Hawaiian solar power is only growing in popularity.[147] The state and its electric utilities should continue to be innovators and leaders in making this transition to a smarter, cleaner electric grid, as the rest of the country can learn from its example.

California

Five of the six California cities included in this report are among the top 15 cities nationally for installed total solar PV capacity—and this dominance is due in large part to California's statewide solar incentive program. In 2006, the California Legislature created the Million Solar Roofs Initiative, now part of the "Go Solar California" campaign, to direct the investment of $3.3 billion in small-scale solar electric power systems. The initiative is on track to reach its 2016 goal of increasing the state's solar generation capacity by 3,000 MW, which will help cut the cost of solar power in half and create a mainstream market for solar power.[148]

The Million Solar Roofs Initiative is composed of three main parts:

1. *The California Solar Initiative*, managed by the state Public Utilities Commission, which seeks to expand the number of solar energy systems installed on existing homes in investor-owned utility territories.
2. *Programs led by publicly-owned utilities*, such as the Sacramento Municipal Utility District or the Los Angeles Department of Water and Power.
3. *The New Solar Homes Partnership*, managed by the California Energy Commission, which seeks to expand the number of solar energy systems installed on new homes in investor-owned utility territories.

California's efforts are working. With 132 MW of solar power, the city of Los Angeles now has more solar power capacity than 39 states had installed at the end of 2012.[149] Its solar power has grown rapidly—Los Angeles had almost three times as much solar PV capacity at the end of 2013 as it had at the end of 2011.[150]

San Diego is hot on Los Angeles' trail with the second highest total solar PV capacity. San Jose ranks second for per-capita solar PV capacity and fourth for cumulative solar PV capacity.

New York

Solar power has also exploded in New York, following the implementation of the "NY-SUN Initiative." This initiative was launched in 2012 and provides cash incentives for residential and commercial customers looking to install solar panels. The program has $800 million to spend on these incentives and on research that will bring down the cost of solar power.[151] In his State of the State address in January 2014, Governor Andrew Cuomo pledged another $1 billion to this program in order to support clean energy development in New York.[152] There are 299 MW of solar power under development in New York State as of January 2014, more than the state had installed in the 10 years prior to the launch of the NY-Sun Initiative.[153] This strong state solar policy has helped place New York City squarely in the top 20 cities for total installed solar PV capacity.

Policy Recommendations

American cities are increasingly leaders in the nation's move toward adoption of clean, affordable solar energy. But there is much remaining that cities can do to take advantage of their solar energy potential.

As solar power continues to grow and thrive, cities should develop good policies to manage distributed generation and work with local utilities to prepare the electric grid to handle more solar power. Cities that begin to incorporate solar power into the grid now will protect residents' health, build more resilient communities and create stronger local economies. In coming years, solar-ready cities will also be ideally situated to benefit from innovative new solar technologies. Adopting strong solar policies at the local, state and federal levels will continue to promote solar energy in leading cities and encourage solar development in those lagging behind, allowing cities to take full advantage of the benefits of clean solar power.

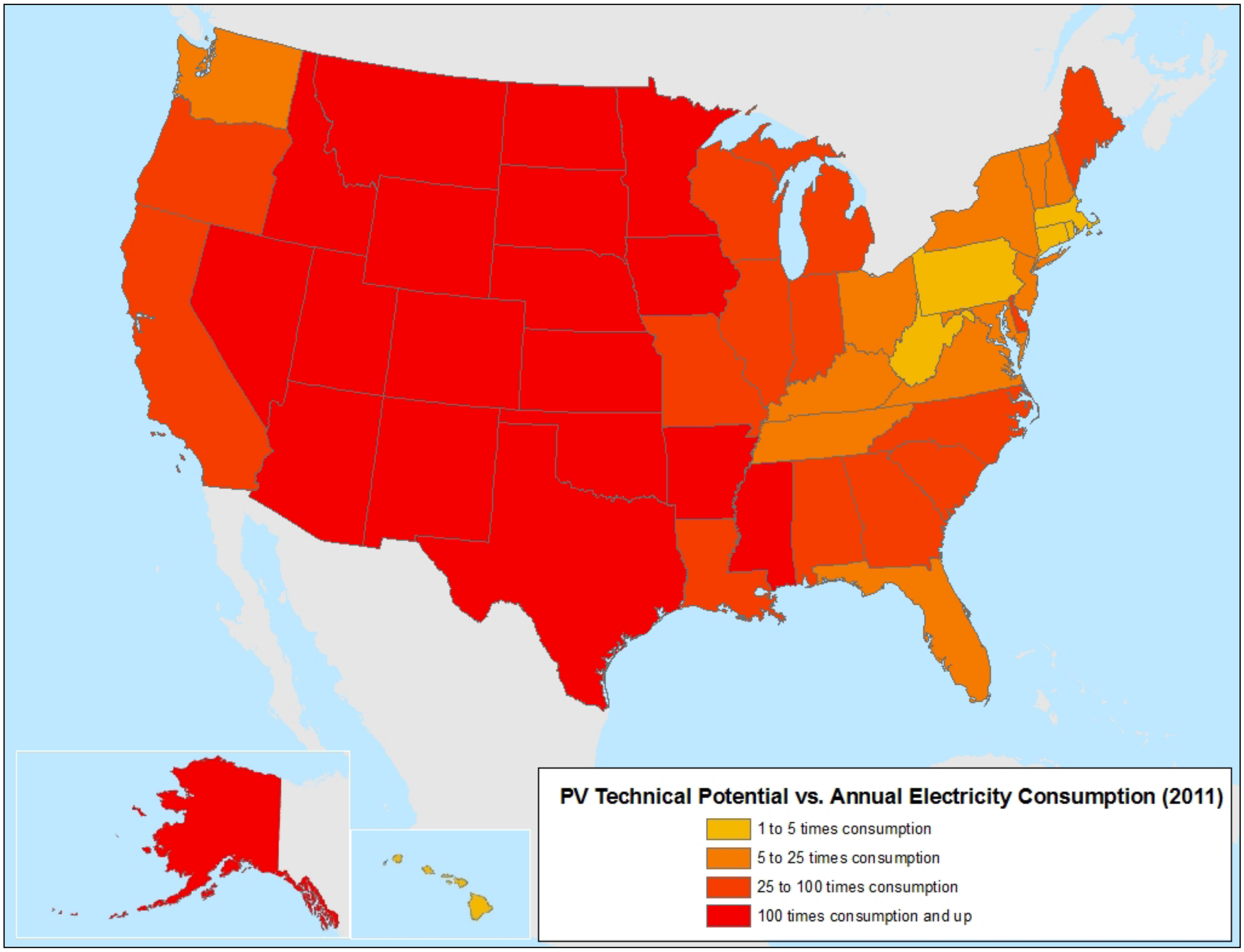
Taking Advantage of America's Solar Energy Potential

America has enough solar energy potential to power the nation several times over. Every one of the 50 states has the technical potential—through both utility-scale and rooftop solar energy systems—to generate more electricity from the sun than it uses in the average year. In 19 states, the technical potential for electricity generation from solar PV exceeds annual electricity consumption by a factor of 100 or more.[154] (See Figure 7.)

An analysis by researchers with the National Renewable Energy Laboratory estimated that rooftop photovoltaic (PV) systems could generate more than 20 percent of the electricity used in the United States each year.[156] Harnessing available rooftop potential is especially important for America's cities, where millions of empty rooftops could be used to generate clean energy. Cities in every region of the United States have enough solar energy potential to power a large share of the economy. The city of Orlando, for example, has 163 million square feet of rooftop space available to support solar power—taking full advantage of that potential would produce enough solar energy to supply 52 percent of the city's electricity demand.[157]

The path to a clean energy future powered increasingly by solar energy is open to every city and state. By adopting strong policies to remove barriers to solar energy and providing individuals and businesses with incentives and financing tools, cities across the country can take part in America's clean energy revolution. State and federal government actions can also support cities in their efforts to "go solar."

Figure 7. Solar PV Technical Potential versus Annual Electricity Consumption by State[155]



Recommendations for Local Government

Cities should take the lead in installing solar power. Local governments should set an example by putting **solar panels on public property**.

Local governments should ensure that every homeowner and business with access to sunlight can exercise the option of generating electricity from the sun. **Solar access ordinances**—which protect homeowners' right to generate electricity from the sunlight that hits their property, regardless of the actions of neighbors or homeowners' associations—are essential protections.

Local governments can also eliminate red tape and help residents to go solar by **reforming their permitting processes**—reducing fees, making permitting rules clear and readily available, speeding up permitting, and making inspections convenient for property owners.[158] The Vote Solar Initiative has laid out a series of best practices that local governments can follow in ensuring that their permitting process is solar-friendly, and the U.S. Department of Energy's SunShot Solar Outreach Partnership provides online tools and case studies to help cities streamline their permitting processes for solar power.[159] Local governments can also ensure that their zoning regulations are clear and unambiguous in allowing solar energy installations on residential and commercial rooftops**.** **Solarize programs** can facilitate the solar installation process by connecting solar installers with a number of solar customers at once.

Cities can also provide **financial or zoning incentives** to encourage the construction of green buildings that incorporate small-scale renewable energy technologies such as solar power. **Property tax credits or abatements** for solar power can effectively incentivize rooftop solar PV installations. Cities can encourage **local lenders to offer financing options** for solar installations. **Building codes** can also help spark the widespread adoption of solar energy, either by requiring new homes and businesses to be "solar-ready" or by requiring the use of small-scale renewable energy in new or renovated buildings. Cities in states where **property assessed clean energy (PACE)** financing is an option for commercial establishments can allow for property tax bills to be used for the collection of payments toward a solar energy system.

Cities with municipal utilities have even greater potential to encourage solar energy. The establishment of **local renewable electricity standards**, strong **net metering and interconnection policies**, **local incentive and rebate programs,** and other pro-solar policies can help fuel the rapid spread of solar energy in the territories of municipal utilities. Regulations allowing for **community solar gardens** also create a significant boost in the local solar market by allowing residents who live in shaded homes or who cannot afford their own rooftop solar projects to invest in community solar projects whose output is credited on their utility bill.

Recommendations for State Government

State governments should set **ambitious targets** for the growth of solar energy, and revisit these targets on a regular basis. For many states, a goal of getting 10 percent of their energy from the sun would set an ambitious standard and make a major difference in reducing the state's dependence on fossil fuels well into the future.

To help achieve those goals, local officials should support states' adoptions of **renewable electricity standards with solar carve outs** that require a significant and growing share of that state's electricity to come from the sun. States should also adopt strong statewide **interconnection and net metering policies**, along with **community solar** policies and **virtual net metering**, to ensure that individuals and businesses are able to sell their excess power back to the electric grid and receive a fair price when they do. **CLEAN contracts** and **value-of-solar credits** can play an important role in ensuring that consumers receive fair compensation for solar energy, so long as the credits fully account for the benefits of solar energy and are sufficient to spur participation in the market. Finally, states should allow **third-party sales** of power to customers; third-party sales allow customers to lease rooftop space to a solar developer for a solar PV installation and then purchase the power from that third-party solar developer. This allows customers who do not wish to own solar panels to participate in the solar market and benefit from doing so with lower electricity bills.[160] States should also take action now to begin planning for the integration of high percentages of solar energy in the electric grid.

Recommendations for Federal Government

The federal government is also responsible for developing the nation's solar energy potential. Strong and thoughtful federal policies lay an important foundation on which state and local policy initiatives are built. Among the key policy approaches that the federal government should take are the following:

- **Continue policies that work**—The federal government has often taken an "on-again/off-again" approach to its support of renewable energy. With federal tax credits for residential solar installations now scheduled to expire and federal tax incentives for business solar installations ramping down from 30 percent to 10 percent at the end of 2016, the federal government should extend these tax credits and ensure that they are sufficiently long-term to provide investor confidence to encourage the development of solar energy markets.[161] The federal government should also continue to offer funding to cities for solar development, as it has been effective in the past: according to a survey from the U.S. Conference of Mayors, funding from the Energy Efficiency and Conservation Block Grant (EECBG) program was effectively used to promote city-level solar projects, with 31 percent of cities using EECBG funding for solar power projects on public buildings. Cities also used funding to advance clean energy financing strategies including PACE and on-bill financing.[162] The U.S. Department of Energy's Solar America Cities program was another effective federal initiative which allowed the federal government to directly incentivize solar power in cities. In 2007 and 2008, the U.S. Department of Energy designated 25 cities as "Solar America Cities," providing $200,000 of financial assistance and $250,000 in technical assistance to remove barriers to the proliferation of solar power in these cities.[163] Many of the "Solar America Cities" in this program are also the top ranked cities in this report.[164] The federal government should continue to offer funding and support for local solar development through programs like Solar America Cities.

- **Continue to set high standards and goals for solar energy—**The U.S. Department of Energy's SunShot Initiative has served as a rallying point for federal efforts to bring the cost of solar energy to competitiveness with electricity from fossil fuel systems, and the federal government should continue to support it. The SunShot Initiative recognizes that while traditional research and development efforts for solar energy remain important, a new set of challenges is emerging around the question of how to bring solar energy to large-scale adoption. This initiative builds on lessons learned from the Solar America Cities program; by continuing to investigate how to best integrate solar energy into the grid, how to deliver solar energy more efficiently and cost-effectively, and how to lower market barriers to solar energy, the SunShot Initiative and other efforts play a key supporting role in the nation's drive to embrace the promise of solar energy.

- **Lead by example—**In December 2013, President Obama signed an executive order directing federal agencies to obtain 20 percent of their annual electricity use from renewable sources by 2020.[165] Solar energy will likely be a major contributor to reaching that goal. The U.S. military has been particularly aggressive in developing its renewable energy capacity, committing to getting one-quarter of its energy from renewable sources by 2025. The military has already installed more than 130 megawatts of solar energy capacity and has plans to install more than a gigawatt of solar energy by 2017.[166] Federal agencies should continue to invest in solar energy. In addition, agencies such as the Department of Housing and Urban Development and Department of Education should work to encourage the expanded use of solar energy in schools and in subsidized housing.

Methodology

This report represents, to the authors' knowledge, the first national-scale comparison of its kind of solar photovoltaic installations in major American cities. There is no uniform national data source that tracks solar energy by municipality and there are only a handful of states that compile this information in a comparable format. As a result, the data for this report come from a wide variety of sources—municipal and investor-owned utilities, city and state government agencies, operators of regional electric grids, non-profit organizations, and the National Renewable Energy Laboratory's "Open PV" database. The data on solar energy installations included in this report come from data sources of various levels of comprehensiveness, with various levels of geographic precision, and that often use different methods of quantifying solar photovoltaic capacity (e.g. alternating current (AC) versus direct current (DC) capacity).

We have worked to obtain data that are as comprehensive as possible, to resolve discrepancies in various methods of estimating solar PV capacity, to limit the solar facilities included to only those within the city limits of the municipalities studied, and, where precise geographic information could not be obtained, to use reasonable methods to estimate the proportion of a given area's solar energy capacity that exists within a particular city. The data are sufficiently accurate to provide an overall picture of a city's adoption of solar power and to enable comparisons with its peers. Readers should note, however, that the data-related challenges described here could have minor impacts on individual cities' rankings. We look forward to building on and further developing our methodology and data sources in future reports and encourage other researchers to do the same. The full list of sources of data for each city is provided in Appendix B along with the details of any data manipulations made.

Selecting the 57 Major Cities

We selected the cities for this report from the 38 states (including the District of Columbia) shown to have installed more than a negligible amount of solar energy (1.5 MW) by the end of 2012, per L. Sherwood, Interstate Renewable Energy Council, *U.S. Solar Market Trends 2012,* July 2013. Cities were selected from within those states that were:

- The principal city of one of the 50 largest metropolitan areas in the United States, or
- For states with a significant amount of solar capacity but without a city in the 50 largest metropolitan areas nationwide, the state's largest city.

We did not include a city from South Carolina.

Collecting Data on Installed Solar PV Capacity

This report compares the capacity of all solar PV installations within the city limits of the chosen 57 cities as of the end of 2013. See Appendix B for a detailed account of the sources of data for each city.

Using the "Open PV" Dataset

In cases where we could not obtain a reliable estimate of solar installations for a particular city, we used the solar capacity estimate reported in Open PV, an open online database of solar energy installations operated by the National Renewable Energy Laboratory (NREL) and funded by the U.S. Department of Energy's Sunshot Initiative. The data in Open PV comes from a variety of sources. Much of it comes in aggregate form from state-level PV incentive programs or utilities. NREL then screens these data for obvious errors before uploading it. A much smaller portion of their data comes from public contributors (installers and other individuals) who create an account on the website and upload information for an installation. These are not initially screened in the same way as other data, but there is a function allowing users to "flag" installations that look suspicious. NREL also has a scheduled automated screen for duplicates that flags potential duplicate installations, which they then follow up on.

NREL performs a thorough update of the Open PV data once a year in which NREL and the Lawrence Berkeley National Laboratory (LBNL) jointly solicit updated information from their data contributors. At the time we conducted our data search, NREL and LBNL had not yet done this update for 2013, meaning the city numbers from Open PV are likely conservative and missing solar PV capacity. Data in the "Open PV" dataset are reported in DC watts.

To calculate city totals from the "Open PV" dataset, we downloaded the full dataset from the website and used the latitude and longitude coordinates associated with each installation to map them in ArcMap. We then "joined" these installations with a layer of Census designated places provided by ESRI to calculate the total solar PV capacity for each city. The vast majority of the data received by Open PV do not have an address, only a zip code. As a result, the totals for some cities may include some PV systems that are outside a city's boundaries but still within the boundaries of a zip code that includes part of a city.

We also used Open PV data when these solar PV capacity totals captured more solar power than other available sources of data. We used the Open PV solar capacity estimate for the following cities: Boston, MA; Dallas, TX; Las Vegas, NV; and Washington, D.C.

NREL's Open PV Website: National Renewable Energy Laboratory, *The Open PV Project*, downloaded from https://openpv.nrel.gov/, 6 March 2014.

Converting from AC watts to DC watts

Jurisdictions and agencies often use different methods of quantifying solar photovoltaic capacity (e.g. alternating current (AC) and direct current (DC)). Solar PV panels produce energy in DC, which is then converted to AC in order to enter the electric grid. Solar capacity reported in AC watts accounts for the loss of energy that occurs when DC is converted to AC.[167]

We attempted to convert all data to DC watts for the sake of accurate comparison. When we could not determine whether the data were reported in AC watts or DC watts, we made the conservative estimate that the data were in DC watts.

To convert the numbers to DC MW, we used NREL's PV watts default derate factor of 0.77. See NREL's website for a detailed explanation of this conversion factor: http://rredc.nrel.gov/solar/calculators/pvWatts/system.html.

The data for the following cities were reported in AC watts and were converted to DC watts: Burlington, VT; Charlotte, NC; Houston, TX; Indianapolis, IN; Los Angeles, CA; Louisville, KY; Manchester, NH; New Orleans, LA; New York City, NY; Raleigh, NC; Sacramento, CA; San Diego, CA; San Jose, CA; and Virginia Beach, VA.

Appendix A: Solar Energy in Major American Cities

Table A-1: Installed Cumulative and Per-Capita Solar PV Capacity by City, End of 2013

Principal City	State	Cumulative Solar PV Capacity (MW)	Cumulative Solar PV Capacity Rank	Solar PV Capacity per Capita (Watts/Person)	Solar PV Capacity per Capita Rank
Albuquerque	NM	16	14	28	16
Atlanta	GA	3	36	6	34
Austin	TX	13	16	16	23
Baltimore	MD	5	28	8	31
Billings	MT	< 1	56	2	50
Boston	MA	12	20	19	22
Buffalo	NY	3	34	12	27
Burlington	VT	2	41	37	11
Charleston	WV	< 1	57	3	46
Charlotte	NC	6	26	8	30
Chicago	IL	11	21	4	40
Cincinnati	OH	4	31	14	24
Cleveland	OH	1	42	4	43
Columbus	OH	2	40	2	49
Dallas	TX	1	44	1	54
Denver	CO	25	10	40	10
Detroit	MI	1	43	2	51
Hartford	CT	< 1	52	3	45
Honolulu	HI	91	5	265	1
Houston	TX	4	32	2	52
Indianapolis	IN	56	7	68	5
Jacksonville	FL	16	13	19	21
Kansas City	MO	2	39	4	42
Las Vegas	NV	13	17	22	20
Los Angeles	CA	132	1	34	13
Louisville	KY	1	50	1	56
Manchester	NH	1	47	9	28
Memphis	TN	3	35	5	38
Miami	FL	< 1	53	1	55

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Principal City	State	Cumulative Solar PV Capacity (MW)	Cumulative Solar PV Capacity Rank	Solar PV Capacity per Capita (Watts/Person)	Solar PV Capacity per Capita Rank
Milwaukee	WI	1	46	2	48
Minneapolis	MN	2	38	5	37
Nashville	TN	4	33	6	36
New Orleans	LA	22	11	60	8
New York	NY	33	8	4	41
Newark	NJ	13	18	46	9
Orlando	FL	2	37	9	29
Philadelphia	PA	9	22	6	35
Phoenix	AZ	96	3	65	6
Pittsburgh	PA	1	49	2	47
Portland	OR	15	15	25	19
Portland	ME	< 1	55	3	44
Providence	RI	1	48	4	39
Raleigh	NC	12	19	30	15
Richmond	VA	1	45	6	33
Riverside	CA	8	24	26	18
Sacramento	CA	16	12	35	12
Salt Lake City	UT	5	27	27	17
San Antonio	TX	84	6	62	7
San Diego	CA	107	2	81	4
San Francisco	CA	26	9	31	14
San Jose	CA	94	4	97	2
Seattle	WA	4	29	7	32
St. Louis	MO	< 1	51	1	53
Tampa	FL	4	30	12	26
Virginia Beach	VA	< 1	54	1	57
Washington	DC	8	23	13	25
Wilmington	DE	7	25	96	3

Appendix B: City-By-City Data Sources

In the descriptions below, we detail the sources of our solar PV capacity totals for each city. We note when the data were reported in AC watts and converted to DC watts. Unless otherwise mentioned, the data were either reported in DC watts, or we made the conservative assumption that the data were in DC watts.

Where we or our data source used zip codes or postal addresses to determine what amount of solar capacity fell within the city limits, the result may be a small overestimation or underestimation of the total solar capacity within the city limits. Estimates based on zip codes or postal addresses may contain a small number of installations that are not within the city limits or miss some installations that are within the city limits.

Albuquerque, New Mexico—16 MW

This number is based on the U.S. Energy Information Administration's report on utility-scale solar PV in Albuquerque as of 2012, plus an estimate of distributed solar PV capacity based on the total amount of customer distributed solar PV capacity in the Public Service Company of New Mexico's (PNM's) service territory (which covers the city of Albuquerque) as of 31 December 2013.[168]

According to PNM, their customers had installed 31 MW of solar PV as of 31 December 2013. PNM was unable to provide an Albuquerque-specific solar capacity total.[169] We scaled this number based on the number of households in Albuquerque in relation to the total number of PNM customers:[170]

Solar PV Capacity in Albuquerque Estimate (MW) = Total Known Solar PV Capacity in Albuquerque + (Total Distributed Solar PV Capacity in PNM Service Territory)*(Households in Albuquerque/Number of PNM Customers in Service Territory)

Solar PV Capacity in Albuquerque Estimate (MW) = 2 MW + ((31 MW)*(222,584/507,000))

Atlanta, Georgia—3 MW

Southface (http://www.southface.org/) provided us with a list of solar PV installations in DeKalb and Fulton counties through 31 December 2013, with latitude and longitude information for each installation. Southface maintains a map of "Georgia Energy Data" at www.georgiaenergydata.org/solarmap, which is believed to be the most comprehensive source of data on solar energy installations in the state of Georgia. These data are believed to be largely in DC watts, but some sources of data relied on by Southface did not specify whether capacity was in DC or AC watts.[171]

The information provided by Southface allowed us to map the solar PV installations using ArcMap, and isolate the capacity within the city limits of Atlanta.

Austin, Texas—13 MW

Austin Energy provided us with a list of customer-rebated solar PV installations and utility-scale solar PV projects with zip codes as of 31 December 2013. They also reported that there is "at least another 700 kW-DC of privately owned non-rebated solar in the city."[172] Within the customer-rebated systems, there were municipal installations that were not listed by zip code, but Austin Energy identified these as almost certainly falling within Austin city limits.

We used ArcMap to determine which zip code points were centered within the city limits of Austin, and counted only installations within those zip codes. The total amount of solar PV in Austin was calculated by adding the customer generation within zip codes centered in Austin (as determined using ArcMap) to the utility-scale projects in Austin to the 0.7 MW of non-rebated solar PV in the city.

Austin Energy, the municipal utility serving Austin, Texas, also generates solar power at a 30-MW solar facility that exists partially in Austin's "extraterritorial jurisdiction" (ETJ). Austin's ETJ includes unincorporated land within 5 miles of Austin's city limits, per AustinTexas.gov, Planning and Development Review Department, *Extraterritorial Jurisdiction: What Is It?*, downloaded from http://www.austintexas.gov/faq/extraterritorial-jurisdiction-etj-what-it, 5 March 2014. Because this solar farm lies outside what are technically the city limits of Austin, we did not include it in Austin's solar total.

Baltimore, Maryland—5 MW

Data on solar PV installed in the city of Baltimore was taken from the SREC registry PJM-GATS.[173] These data only include solar PV installations that are registered in the system before 31 December 2013, but the 4.7 MW included in the GATS report downloaded on 6 March 2014 is larger than the 3.45 MW of solar PV reported in Open PV, and so the larger and more comprehensive estimate was used here.

Billings, Montana—0.2 MW

Northwestern Energy, the utility serving Billings, provided the known amount of solar PV capacity installed in Billings as of 31 December 2012 (0.191 MW), and an estimate of the solar PV capacity installed in Billings during 2013 (0.016 MW).

Boston, Massachusetts—12 MW

The solar PV capacity installed in Boston is taken from NREL's Open PV database. See the Methodology for a description of the data from Open PV.

Data for Boston were also calculated using data from the Massachusetts Executive Office of Energy and Environmental Affairs (EOEEA) in its worksheet, "RPS Solar Carve-Out Qualified Renewable Generation Units," last updated 20 December 2013, downloaded from http://www.mass.gov/eea/energy-utilities-clean-tech/renewable-energy/solar/rps-solar-carve-out/current-status-of-the-rps-solar-carve-out-program.html. This worksheet tracks solar energy projects that receive SREC credit through the state's RES solar carve-out. Because the amount of solar capacity reported to the Massachusetts EOEEA data set was lower than reported in Open PV, the larger and more comprehensive estimate was used here.

Buffalo, New York—3 MW

Data on solar PV capacity in the city limits of Buffalo as of 31 December 2013 was provided by the New York State Energy Research and Development Authority (NYSERDA). This includes only solar PV installations that were funded through NYSERDA, which manages New York's solar PV financial incentive program.

Burlington, Vermont—2 MW

Data were obtained from the Vermont Energy Atlas (http://www.vtenergyatlas.com) a project of the Vermont Sustainable Jobs Fund, the Vermont Center for Geographic Information, Fountains Spatial and Overit Media. Data for the map are provided by the Vermont Clean Energy Development Fund, the Vermont Public Service Board and other sources. Installations were sorted by town name, and we totaled the installations labeled with "Burlington." The data were last updated 16 December 2013. A review of several of the installations found them to be reported in AC watts, so we assumed the total was in AC watts and converted it to DC watts (see Methodology).

Charleston, West Virginia—0.2 MW

The Appalachian Power Company provided an aggregate sum of solar PV capacity within Charleston zip codes.[174] These data were provided through 8 January 2014, so solar PV capacity installed in the first eight days of 2014 may be included.

Charlotte, North Carolina—6 MW

Solar PV capacity within Charlotte was determined by identifying solar PV projects in North Carolina from the North Carolina Utilities Commission (NCUC) worksheet, "New Renewable Energy Facility Registrations Accepted by the North Carolina Utilities Commission, 2008-2013," last updated 31 December 2013. The NCUC docket for each registered solar PV installation was then reviewed, using the NCUC's electronic docket, to determine whether the location of the system was within the city of Charlotte. The NCUC docket for several of the projects referred to their capacity in terms of AC watts, and it was assumed that this held true for the other projects as well. We converted these capacity figures to DC watts (see Methodology).

Chicago, Illinois—11 MW

Commonwealth Edison, the power company serving Chicago, provided us with data on solar PV capacity within the city limits of Chicago.[175] The data includes all installations within the city limits of Chicago through 31 December 2013. Two installations with a combined capacity of 0.8 MW were excluded because the capacity was reported as "a combination of wind and solar PV," and we could not isolate the solar PV capacity. These data were reported in DC watts.

Cincinnati, Ohio—4 MW

The Public Utilities Commission of Ohio provided us with a list of certified renewable energy installations, with address information, updated as of 31 December 2013.[176] We isolated the solar PV capacity of installations within the city limits of Cincinnati by mapping the installation addresses in ArcMap, joining them to the "USA Census Populated Places" layer, and choosing the Cincinnati total. It is important to note that these are "certified" installations; some may have completed the certification process but are not yet online, making this possibly an overestimate of installed solar PV capacity as of 31 December 2013.

Cleveland, Ohio—1 MW

See "Cincinnati, Ohio."

Columbus, Ohio—2 MW

See "Cincinnati, Ohio."

Dallas, Texas—1 MW

The solar PV capacity installed in Dallas is taken from NREL's Open PV database. See the Methodology for a description of the data from Open PV.

Data for Dallas were also provided by Clean Energy Associates (CEA), a clean energy consulting company that ran Dallas-electric utility Oncor's solar PV incentive program through 2012. This solar PV capacity total for Dallas provided by CEA only reflects solar PV installations with the city label "Dallas" through 31 December 2012.[177] The authors requested data for 2013 from Oncor, which now manages its own solar PV incentive program in Dallas, but the company declined to provide Dallas-specific data.[178] That solar PV capacity total is therefore missing a year of solar PV, and a small number of installations listed as "Dallas" may actually fall outside the Dallas city limits. Because the Open PV total was larger than the 1.24 MW reported by Clean Energy Associates, we used the more comprehensive Open PV total.

Denver, Colorado—25 MW

This solar PV capacity total for Denver is an estimate provided by Xcel Energy, the utility that serves the city of Denver. Aside from this estimate, Xcel declined to provide more detailed data on solar PV capacity in Denver as of the end of 2013.[179]

Detroit, Michigan—1 MW

DTE Energy Company provided us with the solar PV capacity within the city limits of Detroit as of 29 January 2014.[180]

Hartford, Connecticut—0.4 MW

This total is the sum of the solar PV capacities of solar facilities listed as approved under Connecticut's Renewable Portfolio Standard, based on a worksheet obtained from the Connecticut Public Utilities Regulatory Authority (PURA) labeled "RPS," obtained from http://www.ct.gov/pura/lib/pura/rps/rps.xls, and last updated on 13 November 2013.

Honolulu, Hawaii—91 MW

We estimated the amount of solar PV capacity in urban Honolulu from county-level data released by Hawaiian Electric, the company serving the county of Honolulu (which is coterminous with the island of Oahu).[181] Within the island of Oahu, the census designated place "urban Honolulu" is the place most comparable with other U.S. cities.[182] Data that would allow for more precise identification of PV facilities within urban Honolulu were requested from Hawaiian Electric Company, the city of Honolulu permitting department, and the Hawaii State Energy Office, but none of these sources could provide data more geographically specific than the county level.

We used the total capacity of solar PV installations within Honolulu County to estimate what percent of this capacity would fall in urban Honolulu.[183]

Solar PV Capacity in urban Honolulu Estimate (MW) = Total Solar PV Capacity in Honolulu County*(Urban Honolulu Households/Honolulu County Households)

Solar PV Capacity in Honolulu Estimate (MW) = 221 MW *(127,652/308,490)

Houston, Texas—4 MW

Centerpoint Energy, the electric utility serving the city of Houston, provided us with solar PV capacity installed in its service area broken down by city.[184] These city breakdowns were compiled using addresses, not city limits, so a small number of installations included in the Houston total may fall outside of the city limits. The data were up to date through 31 December 2013. These data were reported in AC watts, and were converted to DC watts (see Methodology).

Indianapolis, Indiana—56 MW

Indianapolis Power & Light, the investor-owned utility serving Indianapolis, provided us with an aggregate total of solar PV capacity installed within the city limits.[185] The data were up to date through 31 December 2013. These data were reported in AC watts, and were converted to DC watts (see Methodology).

Jacksonville, Florida—16 MW

Jacksonville Electric Authority (JEA), the municipal utility serving the city, provided us with 1) JEA net metering subscriptions with zip codes, and 2) JEA's identified systems within Jacksonville, which included the 15 MW Jacksonville Solar facility where JEA receives energy though a power purchase agreement.[186] Data were complete through 31 December 2013.

Using ArcMap, we identified zip codes that are centered in the city limits of Jacksonville, and summed the capacity of solar PV installations in those zip codes to estimate the solar capacity in Jacksonville. The total amount of solar PV in Jacksonville was calculated by adding the customer generation within Jacksonville zip codes to the other projects JEA identified as being within Jacksonville.

Kansas City, Missouri—2 MW

This solar PV capacity total is based on data that Kansas City Power & Light (KCP&L) reported to the U.S. Energy Information Administration on net metered solar PV installed in its service territory as of September 2013.[187]

The solar PV capacity in Kansas City was estimated based on the total net metered solar PV capacity in KCP&L's service territory using the ratio of households in Kansas City to customers in KCP&L's service territory.[188] KCP&L declined to provide more detailed data on solar capacity within Kansas City.[189]

Solar PV Capacity in Kansas City Estimate (MW) = (Total Non-Located Solar PV Capacity in KCP&L Service Territory)*(Households in Kansas City/Number of KCP&L Customers in Service Territory)

Solar PV Capacity in Kansas City Estimate (MW) = (4.81 MW)*(192,048/511,100)

Las Vegas, Nevada—13 MW

The solar PV capacity installed in Las Vegas is taken from NREL's Open PV database. See the Methodology for a description of the data from Open PV.

Nevada Energy provided us with data on solar PV installations, broken down by zip code, as of 2 January 2014.[190] Using ArcMap, we identified zip codes that are centered in the city limits of Las Vegas, and summed the capacity of solar PV installations in those zip codes to estimate the solar PV capacity in Las Vegas. Using this method and the data from NV Energy, the solar PV capacity in Las Vegas was found to be 12.7 MW. Because this total was smaller than that reported in Open PV, we used the more comprehensive Open PV total.

Los Angeles, California—132 MW

The Los Angeles Department of Water and Power provided us with the solar PV capacity total within the city of Los Angeles.[191] This includes solar PV installed through the Solar Incentive Program, Los Angeles' Feed-in Tariff Program, and their community solar program, through 31 December 2013. These data were reported in AC watts, and were converted to DC watts (see Methodology).

Louisville, Kentucky—1 MW

Louisville Gas & Electric provided us with an aggregate total of installed solar PV capacity within the city limits of Louisville, through 31 December 2013.[192] These data were reported in AC watts, and were converted to DC watts (see Methodology).

Manchester, New Hampshire—1 MW

Public Service of New Hampshire, the electric utility company serving the city of Manchester, provided us with an aggregate total of installed solar PV capacity within the city limits of Manchester, through 31 December 2013.[193] These data were reported in AC watts, and were converted to DC watts (see Methodology).

Memphis, Tennessee—3 MW

The Tennessee Valley Authority renewables program provided us with an aggregate total for solar PV capacity within the city limits of Memphis as of 31 December 2013.[194]

Miami, Florida—0.4 MW

Florida Power & Light provided us with solar PV installed in their service area, broken down by zip code, as of 31 December 2013.[195] We used ArcMap to isolate those zip codes that are centered within the city limits of Miami and counted only solar PV installations in those Miami zip codes in the solar PV capacity total for the city.

Milwaukee, Wisconsin—1 MW

As reported on the website of the city of Milwaukee, the city has "more than 1.25 MW of solar energy being produced in Milwaukee."[196] Our use of 1.25 MW is therefore an underestimate, but we were unable to determine how much over 1.25 MW of solar power the city had installed.[197]

Minneapolis, Minnesota—2 MW

The city of Minneapolis provided us with an aggregate solar PV capacity total as of the end of 2012.[198] This total was aggregated by Xcel, the electric utility serving Minneapolis, which declined to provide us data from 2013.[199] Solar PV installations in 2013 are, therefore, not included in this estimate.

Nashville, Tennessee—4 MW

See "Memphis, Tennessee."

New Orleans, Louisiana—22 MW

Entergy New Orleans, the electric utility serving New Orleans, provided us with this solar PV capacity total, as of 31 December 2013.[200] These data were reported in AC watts, and were converted to DC watts (see Methodology).

New York, New York—33 MW

Data on solar PV capacity in the city limits of New York as of 31 December 2013 were provided by Con Edison, the utility serving New York City.[201] These data were reported in AC watts, and were converted to DC watts (see Methodology).

Newark, New Jersey—13 MW

The solar PV installations supported by New Jersey's Clean Energy Program (NJCEP) are made available online in "NJCEP Solar Installations Report" with city and zip code information.[202] When we collected the data, information was available through 31 December 2013. We found the Newark solar PV total by filtering "city name" for Newark.

Orlando, Florida—2 MW

Orlando Utilities Commission, the municipal utility serving the city of Orlando, provided us with a spreadsheet of solar installations in OUC's service territory, with address information and updated as of 31 December 2013.[203] We filtered this list for "solar PV" projects only, and filtered out any "discontinued" or "pending" projects. We then mapped the qualifying projects in ArcMap and found the capacity of those installations within the city limits of Orlando, as was delimited by the "US Census Populated Places" layer.

Philadelphia, Pennsylvania—9 MW

This solar PV capacity total was found using the SREC-tracker PJM-GATS dataset.[204] We downloaded this list and summed the solar PV capacity within "Philadelphia County" registered before 31 December 2013.

Phoenix, Arizona—96 MW

These data were obtained from the Arizona "Go Solar" website, managed by the Arizona Corporation Commission with information provided by regulated electric utilities.[205] Spreadsheets of solar PV installations are downloadable by utility by zip code on this website. The electric utilities Arizona Public Service (APS) and the Salt River Project (SRP) serve the city of Phoenix. We downloaded their spreadsheets of installations, and selected those installations that were assigned the status of "installed," were listed as "PV," were installed before 31 December 2013, and fell into zip codes centered in the Phoenix city limits. We used ArcMap to identify zip codes that are centered in the city limits of Phoenix, and we used only installations in those zip codes to determine the solar PV capacity in Phoenix.

Pittsburgh, Pennsylvania—1 MW

We received data on the solar PV capacity within the city limits of Pittsburgh from the Office of the Mayor.[206] These data were collected by PennFuture from the Pennsylvania Public Utilities Commission. The data are current to the middle of December 2013.

Portland, Maine—0.2 MW

The solar PV capacity installed in Portland was provided by Central Maine Power.[207] These data are up to date through December 2013.

Portland, Oregon—15 MW

The Portland Bureau of Planning and Sustainability provided us with a solar PV capacity total for the city of Portland (based on Portland zip codes), as of 31 December 2013.[208] The solar PV installations included in this total were part of the two mutually-exclusive

Oregon solar incentive programs, Energy Trust of Oregon and the Oregon Volumetric Incentive Rate pilot program. This number was reported in DC watts.

Providence, Rhode Island—1 MW

The Rhode Island Office of Energy Resources provided us with a spreadsheet of solar installations by city, taken from National Grid's net metering spreadsheet, as of 31 December 2013.[209] We included only those installations within "Providence."

Raleigh, North Carolina—12 MW

See "Charlotte, North Carolina."

Richmond, Virginia—1 MW

The city of Richmond obtained a list of net metered solar PV installations from the Virginia Department of Mines, Minerals and Energy as of 21 January 2014.[210] We used installations listed with the "city name" of Richmond.

Riverside, California—8 MW

The installed solar PV capacity total for Riverside was taken from a solar map maintained by the Riverside Power District: http://www.greenriverside.com/Green-Map-9. This map is updated daily, and the total we used was recorded on 9 January 2014; therefore, some solar PV capacity in this total may have been installed in the first nine days of 2014.

Sacramento, California—16 MW

The Sacramento Municipal Utility District (SMUD) provided us with spreadsheets of individual solar PV installations within the SMUD service area, including address information.[211] These installations included residential and commercial installations that had been incentivized by SMUD and solar PV installed through the Solar Smart new homes program. These installations were mapped in ArcMap using the addresses provided, and joined with the city limits of Sacramento to determine the solar PV capacity within the city limits. The data were provided in AC watts, and were converted to DC watts (see Methodology).

Salt Lake City, Utah—5 MW

The Rocky Mountain Power Company, the electric utility serving Salt Lake City, provided us with solar PV capacity installed as of 31 December 2013 within Salt Lake City.[212]

San Antonio, Texas—84 MW

Solar San Antonio, a non-profit organization in San Antonio, provided us with data on solar installations by zip code as of 31 December 2013.[213] These data are from CPS Energy, the municipal utility serving the city of San Antonio. We used ArcMap to identify zip codes that are centered in the city limits of San Antonio, and we used only installations in those zip codes to determine the solar PV capacity in San Antonio.

San Diego, California—107 MW

San Diego Gas and Electric provided us with this total, which includes net metered installations and non-net metered solar projects within the city limits of San Diego, through 31 December 2013.[214] These data were reported in AC watts, and were converted to DC watts (see Methodology).

San Francisco, California—26 MW

The City and County of San Francisco provided us with the installed solar PV capacity within the city limits of San Francisco, which includes "everything connected to the grid" in San Francisco. They could only provide data through August 2013.[215]

San Jose, California—94 MW

This solar PV capacity total for San Jose was provided by Pacific Gas & Electric within the city limits of San Jose as of 5 January 2014.[216] These data were reported in AC watts, and were converted to DC watts (see Methodology).

Seattle, Washington—4 MW

Seattle City Light (SCL), Seattle's municipal utility, and Seattle's Department of Planning and Development estimate that there are 6 MW of solar PV capacity installed within SCL's service territory as of the end of 2013, which is larger than the city of Seattle. Seattle City Light and Seattle's Department of Planning and Development did not have a more specific number available.[217] We scaled this number based on the number of homes in Seattle and the number of total customers in Seattle City Light's service territory.[218]

Solar PV Capacity in Seattle Estimate (MW) = (Total Non-Located Solar PV Capacity in Seattle City Light's Service Territory)*(Households in Seattle/ Number of Seattle City Light Customers in Service Territory)

Solar PV Capacity in Seattle Estimate (MW) = 6 MW * (285,476/403,000)

St. Louis, Missouri—0.4 MW

The Missouri Department of Economic Development maintains a list of "Certified Solar Renewable Generation Facilities," which includes information on customer solar generation in Ameren Missouri's service territory (Ameren is the utility serving St. Louis Missouri).[219] As of 17 April 2013, Ameren had 3.66 MW of solar PV installed within its service territory. We scaled that figure to St. Louis using the number of households in St. Louis as compared to the total number of customers in Ameren Missouri's service territory.[220]

Solar PV Capacity in St. Louis Estimate (MW) = (Total Non-Located Solar PV Capacity in St. Louis City Light's Service Territory)*(Households in St. Louis/ Number of Ameren Customers in Service Territory)

Solar PV Capacity in St. Louis Estimate (MW) = 3.66 MW*(139,840/1,200,000)

Tampa, Florida—4 MW

Tampa Electric provided a spreadsheet of installed solar PV capacity, with city name and zip code information.[221] We used ArcMap to determine which zip codes are centered within the city limits of Tampa and used only the reported solar capacity within those zip codes to estimate the capacity within the city limits.

Virginia Beach, Virginia—0.3 MW

Dominion Virginia Power provided us with data on solar PV installed in the city limits of Virginia Beach as of 31 December 2013.[222] These data were reported in AC watts, and were converted to DC watts (see Methodology).

Washington, D.C.—8 MW

The solar PV capacity installed in Washington, D.C. is taken from NREL's Open PV database. See the Methodology for a description of the data from Open PV.

PJM GATS also tracks solar PV installed in Washington D.C., but its total was less complete than the solar PV capacity reported in Open PV.

Wilmington, Delaware—7 MW

The Delaware Public Service Commission maintains a downloadable spreadsheet of certified renewable energy facilities.[223] We used this spreadsheet to find the solar PV capacity in Wilmington, based on postal address, as of 31 December 2013.

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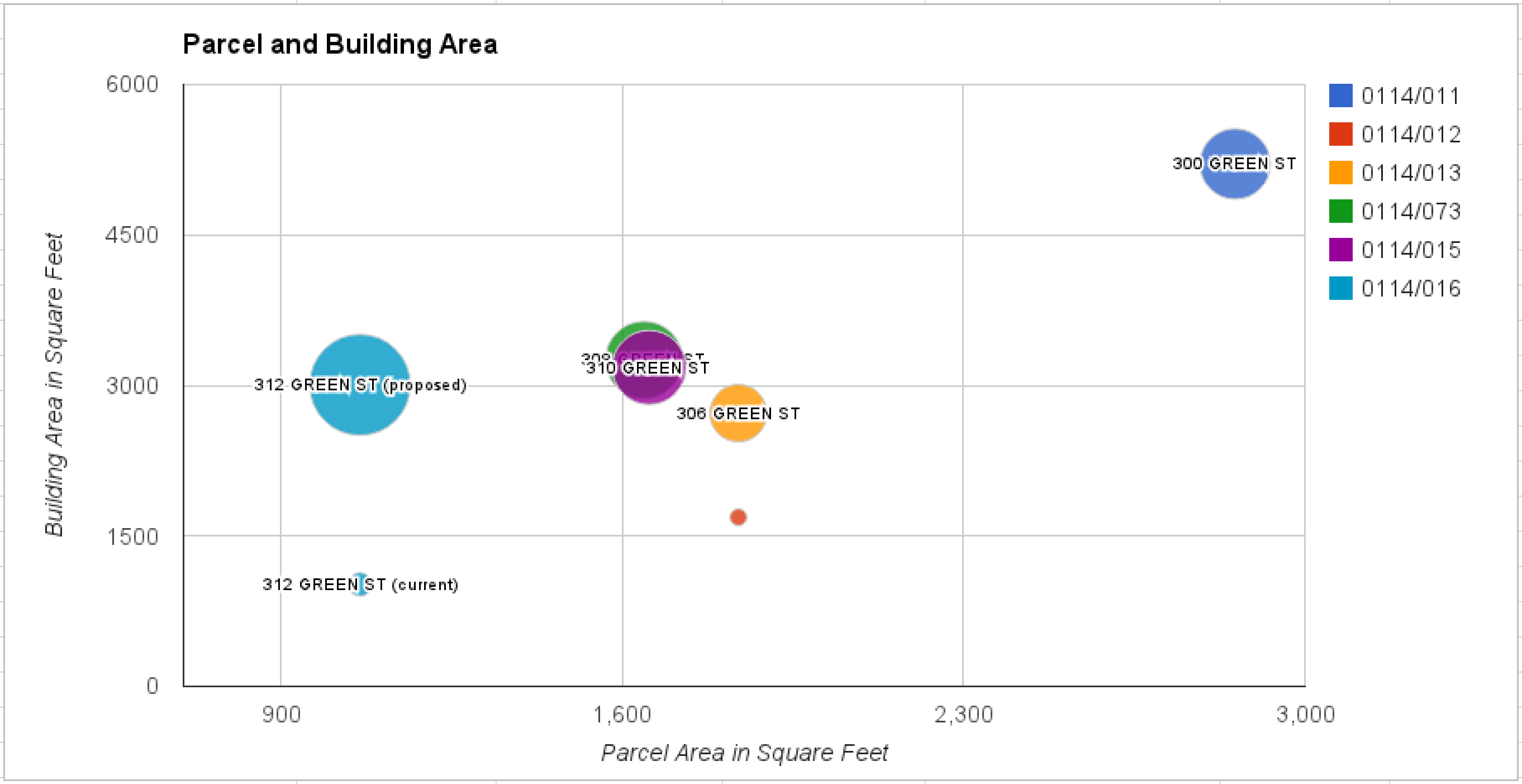
Address	Parcels (block/lot)	Building Area (ft^2)	Parcel Area (ft^2)	Density Ratio (Building : Parcel)
300 GREEN ST	0114/011	5,208	2,857	1.82
304 and 304A Green	0114/012	1,688	1,838	0.92
306 GREEN ST	0114/013	2,724	1,838	1.48
308 GREEN ST	0114/073	3,253	1,644.50	1.98
310 GREEN ST	0114/015	3,180	1,655	1.92
312 GREEN ST (current)	0114/016	1,017	1,062	0.96
312 GREEN ST (proposed)	0114/016	3006	1,062	2.83



Address	Parcels (block/lot)	Building Area (ft^2)	Parcel Area (ft^2)	Density Ratio (Building : Parcel)		
Source: http://propertymap.sfplanning.org/?dept=planning						

Source: http://propertymap.sfplanning.org/?dept=planning

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