



Shining Cities 2019

The Top U.S. Cities for Solar Energy



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Cover photos:

Top: Solar panels in the view of the United States Capitol. *Credit:* Cosimina Panetti via U.S. Department of Energy.

Left: Installing solar panels on the Kingsley Association community center in Pittsburgh. *Credit:* Seth Finch, winner of Environment America's 2016 solar photo contest.

Right: Solar panels atop the Nome Hospitality building in Rancho Cordova, California. *Credit:* Michelle Parry via U.S. Department of Energy.

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Executive Summary

Solar power is expanding rapidly. The United States now has over 60 gigawatts (GW) of solar photovoltaic (PV) capacity installed – enough to power nearly one in every 11 homes in America.¹ Hundreds of thousands of Americans have invested in solar energy and millions more are ready to join them.

America’s major cities have played a key role in the clean energy revolution and stand to reap tremendous benefits from solar energy. As population centers, they are major sources of electricity demand and, with millions of rooftops suitable for solar panels, they have the potential to be major sources of clean energy production as well.

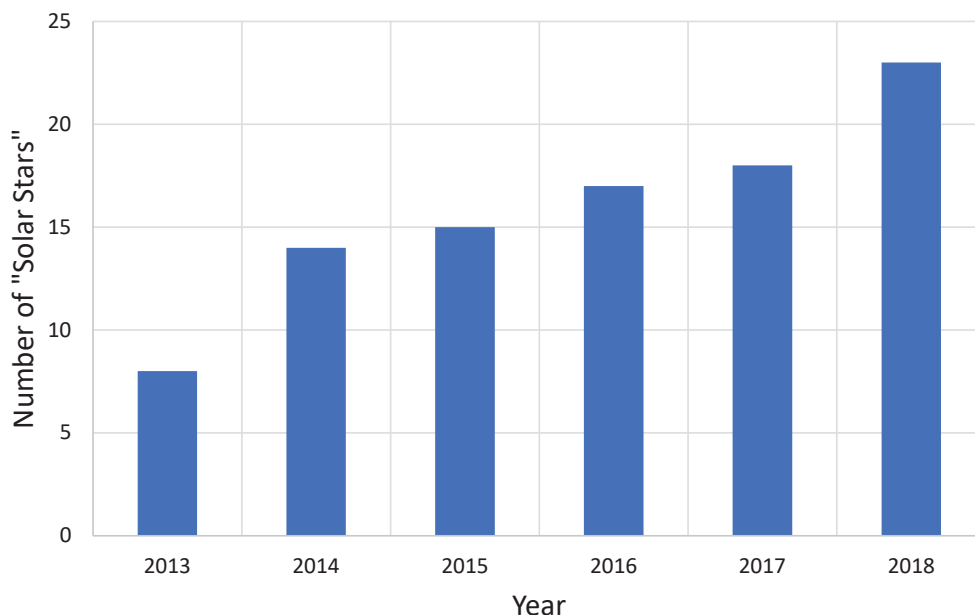
Our sixth annual survey of solar energy in America’s biggest cities finds that the amount of solar power installed in just 20 U.S. cities exceeds the

amount installed in the entire United States at the end of 2010.² **Of the 57 cities surveyed in all six editions of this report, 79 percent more than doubled their total installed solar PV capacity between 2013 and 2018.**

To continue America’s progress toward renewable energy, cities, states and the federal government should adopt strong policies to make it easy for homeowners, businesses and utilities to “go solar.”

The cities with the most solar PV installed per resident are the “Solar Stars” – cities with 50 or more watts of solar PV capacity installed per capita. **In 2013, only eight of the cities surveyed for this report had enough solar PV per capita to be ranked as “Solar Stars,” but now 23 cities have earned the title.**

Figure ES-1. The Number of “Solar Stars” (Cities with >50W of Solar PV per Capita) in Each Edition of *Shining Cities*



Honolulu leads the United States for solar power per person among cities surveyed, followed by San Diego, San Jose and Burlington, Vermont. All of the “Solar Stars” have experienced dramatic growth in solar energy and are setting the pace nationally for solar energy development. (See Figure ES-2 and Table ES-1).

One-third of the 57 cities surveyed in all six editions of this report more than quadrupled their installed solar PV capacity from 2013 to 2018.

Los Angeles leads the nation in total installed solar PV capacity among the 69 cities surveyed in this report, as it did from 2013 to

2015 and in 2017, after briefly being topped by San Diego in 2016. Since 2016, Los Angeles has added over 150 MW of solar capacity. (See Figure ES-3 and Table ES-2).

Leading solar cities can be found in every region of the country. Leaders in per capita solar capacity by census region include **Honolulu** in the Pacific region, **Las Vegas** in the Mountain region, **Indianapolis** in the North Central region, **San Antonio** in the South Central region, **Washington, D.C.**, in the South Atlantic region and **Burlington, Vermont**, in the Northeast region.

Figure ES-2. Major U.S. Cities by Installed Solar PV Capacity Per Capita, End of 2018 (Watts per Person)

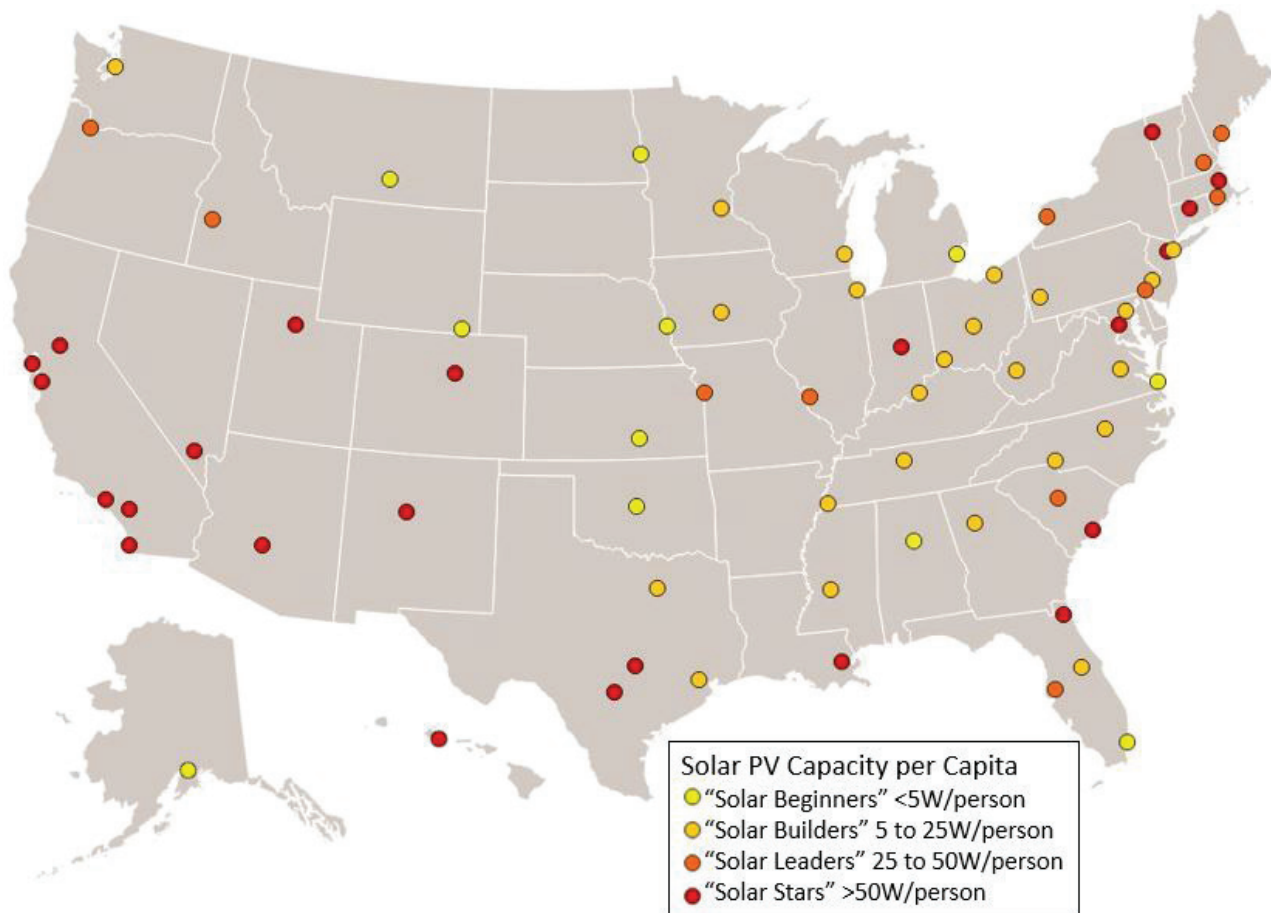


Table ES-1. The “Solar Stars” (Cities with 50 or More Watts of Solar PV per Person, End of 2018)

Per Capita Rank	City	State	Per Capita Solar PV Installed (Watts-DC/person) [†]	Change in Per Capita Rank 2017 to 2018	Total Solar PV Installed (MW-DC)	Total Solar PV Rank
1	Honolulu	HI	646.4	0	226.5	4
2	San Diego	CA	247.5	0	351.4	2
3	San Jose	CA	194.9	0	201.7	5
4	Burlington	VT	187.3	+1	7.9	37
5	Las Vegas	NV	162.2	+1	104.1	9
6	Phoenix	AZ	145.3	+1	236.2	3
7	Indianapolis	IN	143.5	-3	123.8	8
8	Riverside	CA	138.3	+1	45.3	16
9	Denver	CO	129.6	-1	91.4	10
10	Albuquerque	NM	128.9	+2	72.0	11
11	Salt Lake City	UT	126.9	-1	25.5	21
12	San Antonio	TX	123.6	-1	186.9	7
13	New Orleans	LA	107.3	0	42.2	18
14	Los Angeles	CA	105.0	+1	419.9	1
15	Washington	DC	91.7	+2	63.6	12
16	Newark	NJ	88.6	0	25.3	22
17	Sacramento*	CA	84.4	-3	42.3	17
18	Charleston	SC	75.5	N/A	10.2	34
19	Jacksonville	FL	62.1	+2	55.4	13
20	San Francisco	CA	57.8	-2	51.1	14
21	Boston	MA	54.6	-2	37.4	19
22	Austin*	TX	53.2	+1	50.6	15
23	Hartford	CT	50.1	+4	6.2	42

† Throughout the report, includes all solar PV capacity (rooftop and utility-scale solar installations) within the city limits of each city. Does not include solar power installed in the extraterritorial jurisdictions of cities, even those installed by or under contract to municipal utilities. See Methodology for an explanation of how these rankings were calculated. See Appendix B for city-specific sources of data.

* Due to an improvement in methodology or data source for this city, total and per capita solar PV capacity reported in this table are not directly comparable with estimates for this city in previous editions of this report. See Appendix B for details on specific cities.

Many smaller cities and towns are also going big on solar energy.

- **Santa Fe, New Mexico**, had 19 MW of cumulative solar PV capacity installed as of the end of 2018, equivalent to 225 watts per person. That’s more solar PV capacity per capita than any city on our list other than Honolulu and San Diego.³
- **Tallahassee, Florida**, has enough solar PV capacity installed (30 MW total and 157 watts per person) to be ranked as a leading “Solar Star.”⁴
- **Trenton, New Jersey**, also has enough solar PV capacity installed to be ranked as a “Solar Star.” With New Jersey’s new Community Solar Energy

Pilot Program, residents who cannot install their own solar panels will now be able to “go solar” by purchasing electricity from community solar projects.⁵

Fossil fuel interests and some utilities are working to slow the growth of distributed solar energy. Over the past few years, many states have considered or passed cuts to net metering – the critical practice of crediting solar energy customers for the excess energy they supply to the grid.⁶ Additionally, some states and utilities are now targeting solar customers with special fees, charges and rate designs in order to reduce the appeal and financial prom-

Figure ES-3. Major U.S. Cities by Total Installed Solar PV Capacity, End of 2018 (MW)

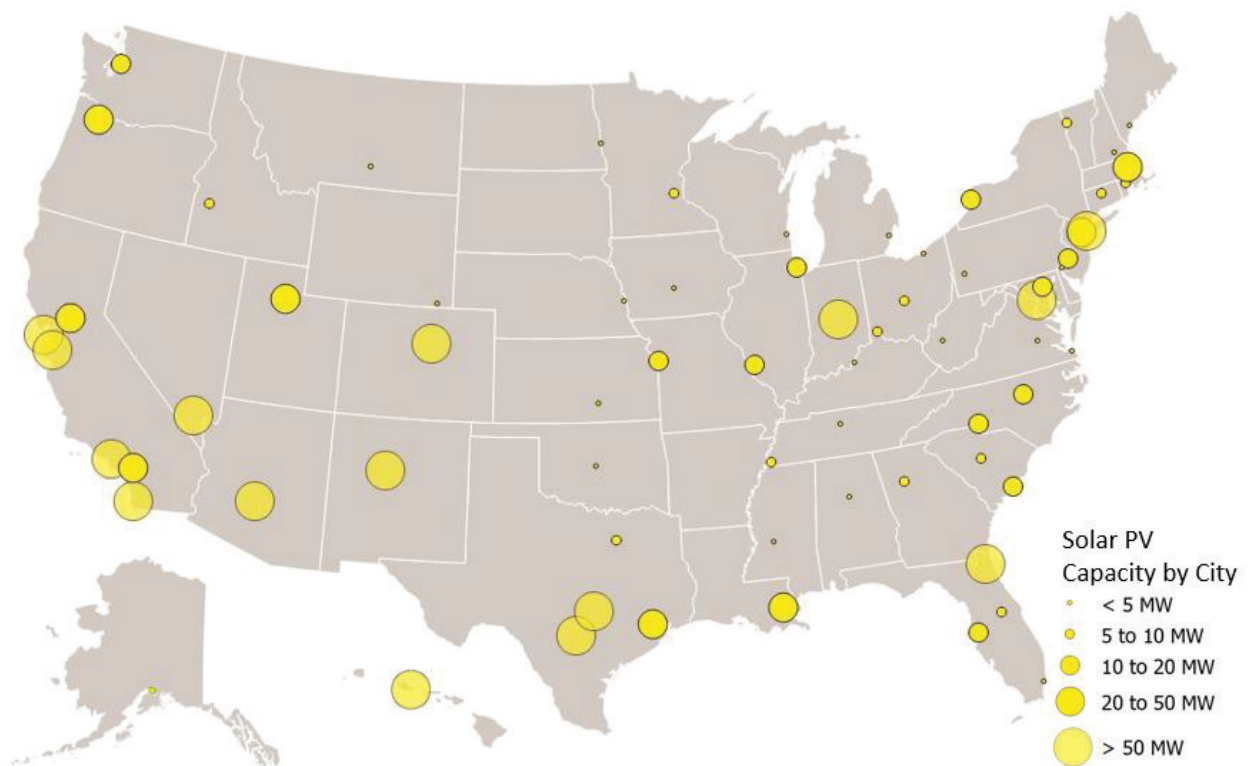


Table ES-2. Top 20 Shining Cities by Total Installed Solar PV Capacity, End of 2018

Total Solar PV Rank	City	State	Total Solar PV Installed (MW-DC)	Rooftop Solar PV Potential on Small Buildings (MW) [†]	Per Capita Rank	Per Capita Solar PV Installed (Watts-DC/person)
1	Los Angeles	CA	419.9	5,444	14	105.0
2	San Diego	CA	351.4	2,219	2	247.5
3	Phoenix	AZ	236.2	2,981	6	145.3
4	Honolulu	HI	226.5	N/A	1	646.4
5	San Jose	CA	201.7	1,639	3	194.9
6	New York	NY	200.0	1,277	36	23.2
7	San Antonio	TX	186.9	3,721	12	123.6
8	Indianapolis	IN	123.8	N/A	7	143.5
9	Las Vegas	NV	104.1	946	5	162.2
10	Denver	CO	91.4	677	9	129.6
11	Albuquerque	NM	72.0	1,252	10	128.9
12	Washington	DC	63.6	344	15	91.7
13	Jacksonville	FL	55.4	1,715	19	62.1
14	San Francisco	CA	51.1	672	20	57.8
15	Austin*	TX	50.6	1,443	22	53.2
16	Riverside	CA	45.3	612	8	138.3
17	Sacramento*	CA	42.3	777	17	84.4
18	New Orleans	LA	42.2	1,277	13	107.3
19	Boston	MA	37.4	341	21	54.6
20	Portland	OR	31.2	1,397	24	48.2

* Due to an improvement in methodology or data source for this city, total and per capita solar PV capacity reported in this table are not directly comparable with estimates for this city in previous editions of this report. See Appendix B for details on specific cities.

† Reflects the maximum technical solar PV capacity that could be installed on appropriate small building rooftops in each city. These figures were calculated by the U.S. Department of Energy (DOE): U.S. DOE, Energy Efficiency & Renewable Energy State & Local Energy Data, available at apps1.eere.energy.gov/sled/#. Data were unavailable for cities with "N/A" listed.

ise of installing solar panels. These changes, such as imposing demand charges and other electric bill fees only on solar customers specifically, could cause solar panel owners to pay as much for electricity as other customers, even though they consume less electricity from the grid.⁷

U.S. cities have only begun to tap their solar energy potential. Some of the cities in this report could generate hundreds of times more solar power than they do today. A National Renewable Energy Laboratory (NREL) study estimated that building rooftops alone are technically capable of hosting enough solar energy to cover the annual electricity needs of more than 121 million American homes – about as many as exist in the U.S.⁸ Cities can go even farther by encouraging solar installations on large buildings and stand-alone utility-scale installations.

To take advantage of the nation’s vast solar energy potential and move America toward an economy powered by 100 percent renewable energy, city, state and federal governments should adopt a series of strong pro-solar policies.

Local governments should, among other things:

- Establish goals for solar energy adoption and programs to meet those goals.
- Implement solar access ordinances to protect residents’ right to generate solar energy on their own property.
- Make permitting, zoning and inspection processes easy, quick and affordable.
- Expand access to solar energy to apartment dwellers, low-income residents, small businesses and nonprofits through community solar projects and third-party financing options, such as power purchase agreements (PPAs).

- Implement policies that support energy storage, electric vehicle smart charging and microgrids.
- Require new homes and buildings to be built with solar panels, or at least be constructed to be “solar-ready.”
- Support and push for strong state-level solar policies.

State governments should, among other things:

- Set or increase renewable energy targets for utilities to supply 100 percent of their electricity using renewable energy, and adopt specific requirements for solar energy adoption.
- Adopt and preserve strong statewide interconnection and net metering policies.
- Ensure that electric rate designs encourage solar adoption.
- Encourage solar energy installations through rebate programs, tax credits and financing programs such as low or zero interest loans and Property Assessed Clean Energy (PACE) financing.

The federal government should, among other things:

- Continue and expand financing support for solar energy, particularly the Solar Investment Tax Credit, which provides a 30 percent tax credit for the cost of installing solar panels. The credit should be extended to apply to energy storage systems, such as home batteries.
- Continue to support research to drive solar energy power innovations, such as the U.S. Department of Energy’s Solar Energy Technologies Office.

Introduction

Solar power shines as an American success story. A rarity just a decade ago, the United States now has enough solar energy installed to power 11.3 million homes – nearly one in every 11 homes in America.⁹ After a year of rapid growth in

2018, America now has 1.9 million solar photovoltaic (PV) installations, with a total capacity that exceeds 60 gigawatts (GW).¹⁰ Improvements in solar technology and rapidly declining costs make solar energy more attractive with each passing year.

Jared Heidemann, U.S. Department of Energy via Flickr, CC-BY-1.0.



Solar panels overlook the Tulsa skyline from the city's Central Library.

Over the past decade, solar power has taken off in America's cities. In these densely-populated areas, solar energy now powers thousands of homes, office buildings, schools and businesses, all while helping to clean the air and reduce carbon pollution.

Many cities have demonstrated exceptional leadership in adopting solar power. The key difference between cities that lead and those that lag is effective public policy.

State and local policies are core ingredients of a successful solar market. In the cities where solar energy succeeds, utilities fairly credit solar homeowners for the energy they supply to the grid, installing solar panels is easy and hassle-free, attractive options for solar financing exist, and local governments and officials are committed to support solar energy development.

Solar energy adoption in every city also relies on effective federal policies. Federal tax credits for renewable energy make an important contribution to encouraging growth in solar power. However, the current law calls for residential credits to phase out in 2022.¹¹

American solar energy is at a tipping point. In more than half the states, electricity from solar panels is cost-competitive with electricity generated by fossil fuels when all factors are taken into account – includ-

ing important incentives and subsidies.¹² The rapid spread of low-cost solar power, however, poses a threat to the business models of fossil fuel interests and some utilities, who have united in an effort to slow the progress of solar energy. In 2018 alone, 36 states took action related to residential fixed charges or minimum balance increases to electric bills, some of which could cause solar customers to pay as much for electricity as regular customers, even though they use much less electricity from the grid.¹³ Over the past few years, many states have also considered or passed cuts to net metering – the critical practice of crediting solar energy customers for the excess energy they supply to the grid.¹⁴

The outcome of those battles will determine how rapidly cities and the rest of the nation can gain the benefits of solar energy. The urgent need to reduce America's contribution to global warming – along with the other environmental and public health threats posed by fossil fuel production and use – mean that we cannot afford to wait.

Cities continue to lead the way in the transition to a 100 percent clean, renewable energy system. With tremendous unmet potential for solar energy in every city, now is the time for cities, as well as states and the federal government, to recommit to the policies that are bringing a clean, renewable energy system closer to reality.

Cities continue to lead the way in the transition to a 100 percent clean, renewable energy system.

Solar Energy Benefits Cities

Solar energy helps cities in many ways, including by combating global warming, reducing local air pollution, strengthening the electric grid, and stabilizing energy costs for residents.

Solar Energy Reduces Greenhouse Gas Emissions

America can limit future impacts of global warming by slashing the use of the main contributor, fossil fuels.¹⁵ Unlike fossil fuel power plants, solar energy systems produce no carbon emissions. Even when emissions from manufacturing, transportation and installation of solar panels are included, solar energy

produces 96 percent fewer greenhouse gas emissions than electricity from coal over its entire life cycle, and 91 percent fewer greenhouse gas emissions than electricity from gas-fired power plants.¹⁶ By replacing electricity from fossil fuels with solar power, we can dramatically cut carbon pollution and reduce the impacts of global warming.

Solar Energy Reduces Air Pollution, Improving Public Health

Pollution from fossil fuel combustion causes major health problems in American cities. According to the World Health Organization, outdoor air pollution is

Jared Heidemann, U.S. Department of Energy via Flickr, CC-BY-1.0.



Solar panels generate power at the Market One commercial building in Des Moines, Iowa.

linked to strokes, heart disease, acute respiratory disease, asthma and lung cancer.¹⁷ These conditions can lead to disability, prolonged absences from work or school, and even death.¹⁸ One study estimated that air pollution from power plants causes between 7,500 and 52,000 deaths in the U.S. annually.¹⁹ Cities in the Midwest and Mid-Atlantic, such as Baltimore, Cleveland and St. Louis, bear a particularly heavy health burden from pollution due to the high number of coal-fired power plants in those areas.²⁰

Solar energy reduces the need for electricity generated by polluting, fossil fuel resources. From 2007 to 2015, wind and solar energy were estimated to prevent between 3,000 and 12,700 premature deaths in the U.S. by improving air quality.²¹ The times when the most solar energy is generated, i.e. when there is the most sunlight, tend to coincide with times of peak demand for air conditioning. As a result, solar energy can help replace the need for “peaker” power plants, which only operate when electricity demand is highest and tend to be the oldest, most expensive and most polluting power stations.²² Also,

some local air pollution impacts are exacerbated by high temperatures, meaning replacing high-polluting “peaker” plants with solar energy further benefits public health.²³

Solar Energy Makes Cities More Resilient to Disasters

Solar energy, when paired with energy storage, can help keep the power on during disasters when the main electric grid has gone down. Hospitals, fire stations and storm shelters can use solar and battery storage in order to stay online and respond to community needs in times of crisis.²⁴

Solar energy also helps cities conserve water in times of drought. Nationally, electricity production accounts for about 40 percent of freshwater withdrawals.²⁵ Unlike the fossil fuel-fired power plants that currently generate the bulk of American electricity, solar PV systems do not require high volumes of water for cooling.²⁶ In fact, solar PV systems consume 1/500th of the water that coal power plants do over their life-cycle and 1/80th of the water that natural gas plants do, per unit of electricity produced.²⁷

Batteries and Electric Vehicles Expand Solar Energy’s Potential

Energy storage systems and electric vehicles expand the opportunity to use solar power, helping to further reduce greenhouse gas emissions and air pollution by replacing fossil fuels. When solar panels produce more electricity than is immediately needed by a home, energy storage systems can store the energy to be used later, when solar panels are not producing enough energy to provide for a consumer’s immediate needs. This allows solar panels to meet a higher percentage of homes’ and the electric grid’s needs more of the time, and prevents excess solar energy from being wasted.³² Electric vehicles can serve a similar function by charging when solar panels are producing excess energy. EVs also enable solar energy to power an additional sector of the economy – our transportation system – which surpassed electricity generation as the leading source of greenhouse gas emissions in the United States in 2016.³³

Solar Energy Benefits Consumers

Cities that make solar energy accessible and affordable provide direct and indirect economic benefits to their residents, including solar energy customers and other members of the community.

Homeowners and business owners who install solar panels on their buildings can generate their own electricity, which helps protect them from spikes and general increases in fossil fuel prices – particularly when they pair their solar panels with energy storage systems, such as batteries.²⁸

In states with net metering, when solar panel owners generate more energy than they need at a given point in time they can export this energy to the grid in exchange for credit. They can then use the credit to pay for electricity they receive from the grid later, when their solar panels aren't generating enough energy to provide for their needs. On average, about 20 to 40 percent of a solar energy system's output is exported back to the electric grid, serving nearby customers.²⁹ The credits collected by system owners can help them recoup initial investments made in PV systems over time.

Distributed Solar Energy Benefits the Broader Electric Grid

The benefits of solar energy extend beyond the buildings on which PV panels are installed. Having more customers produce their own electricity with solar PV panels, particularly when they are paired with batteries, helps utilities avoid the need to turn on – and sometimes even build – “peaker” power plants that are only used when electricity demand is highest. These power plants tend to be the most expensive to operate, so replacing them with solar energy can help save electric utilities money. Also, generating more electricity closer to the locations where it is used reduces the need to construct or upgrade expensive transmission and distribution lines. Localized electricity generation minimizes the amount of energy lost during transmission as well, improving the efficiency of the electric grid.³⁰ If electric utilities pass these savings on in the form of lower electric bill rates, solar energy can help save all electric customers money.³¹

America's Top Shining Cities Are Building a Clean Energy Future

City leaders and residents are taking advantage of the significant opportunities offered by solar energy. In leading cities, officials are setting ambitious goals for solar energy adoption, putting solar panels on city buildings, and working with utilities to upgrade the electric grid and offer their customers incentives to invest in solar energy systems. In these cities, permitting departments are taking steps to reduce fees and processing times for solar installation applications. As a result, city residents, individually and with their neighbors, are cutting their electricity bills and contributing to a cleaner environment by purchasing solar energy.

This report is our sixth review of installed solar PV capacity in major U.S. cities. This year, the list of cities surveyed starts with the primary cities in the top 50 most populous Metropolitan Statistical Areas in the United States, according to the U.S. Census Bureau.³⁴ If a state did not have a city included in that list, its most

populous city was added. For a complete list of cities, see Appendix A. We were unable to obtain reliable data for Little Rock, Arkansas, so the city was dropped from the list. Also, Sioux Valley Energy, the utility that serves Sioux Falls, South Dakota, reported that there is no solar capacity installed in Sioux Falls' city limits connected to their grid.³⁵ In previous reports, we have ranked the city of Columbia, South Carolina, but Charleston, South Carolina, now has a higher population, so both cities are featured in this report.

There is no uniform and comprehensive national data source that tracks solar energy capacity by municipality, so the data for this report come from a variety of sources – municipal and investor-owned utilities, city and state government agencies, operators of regional electric grids and non-profit organizations (see Methodology). This may lead to 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. In some cases, more precise methods were found for measuring solar capacity for this year's report, meaning that comparisons with data reported in previous reports may not be valid. Such cases are noted in Appendix B.

Leading Cities Continue to Grow in Solar Capacity Per Capita

The cities ranked in this report vary in size, population and geography. Measuring solar PV capacity installed per city resident, in addition to comparing total installed solar PV capacity, provides a metric for how successfully cities have tapped their solar power potential in relation to their size.

Figure 1. U.S. Cities by Installed Solar PV Capacity Per Capita, End of 2018 (Watts per Person)

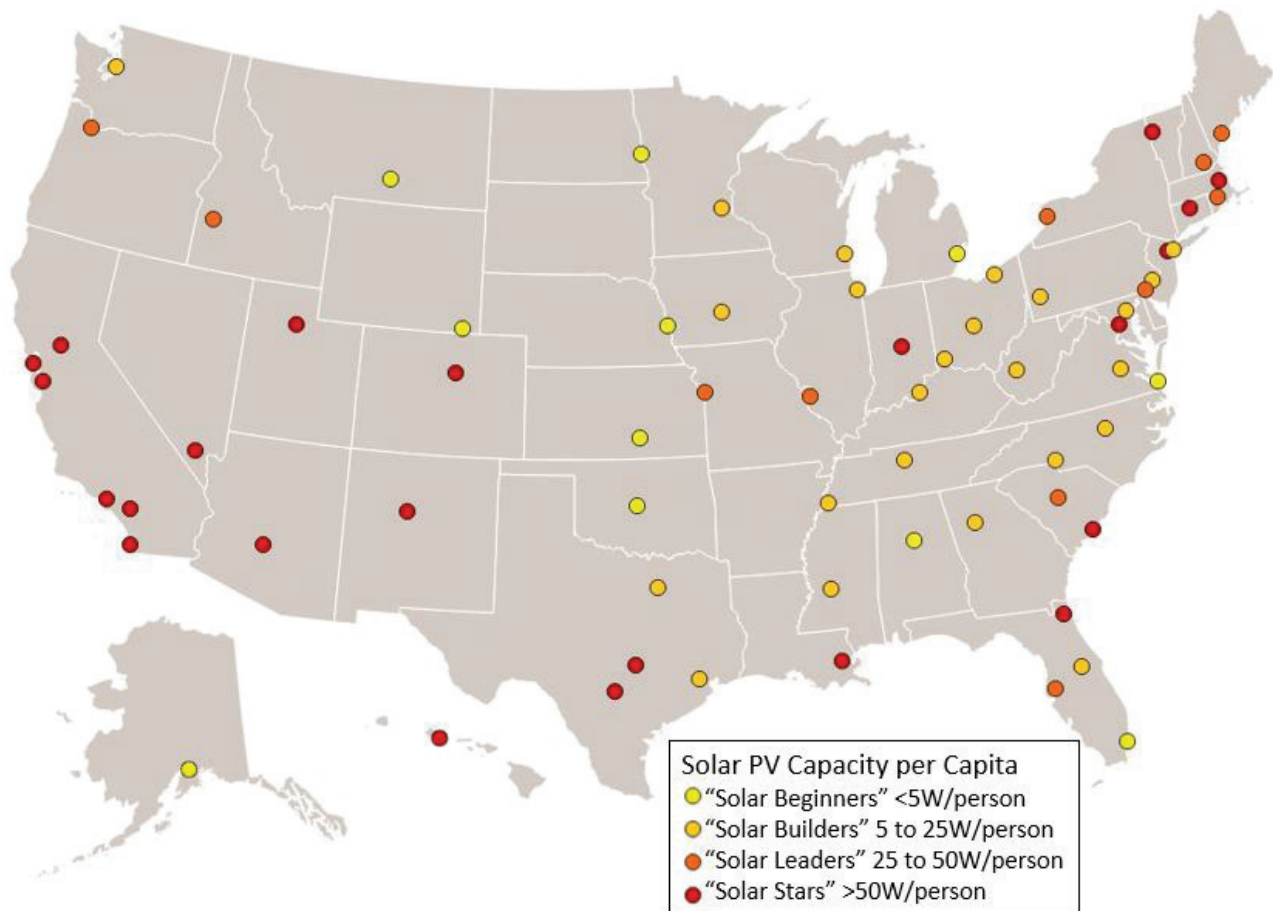
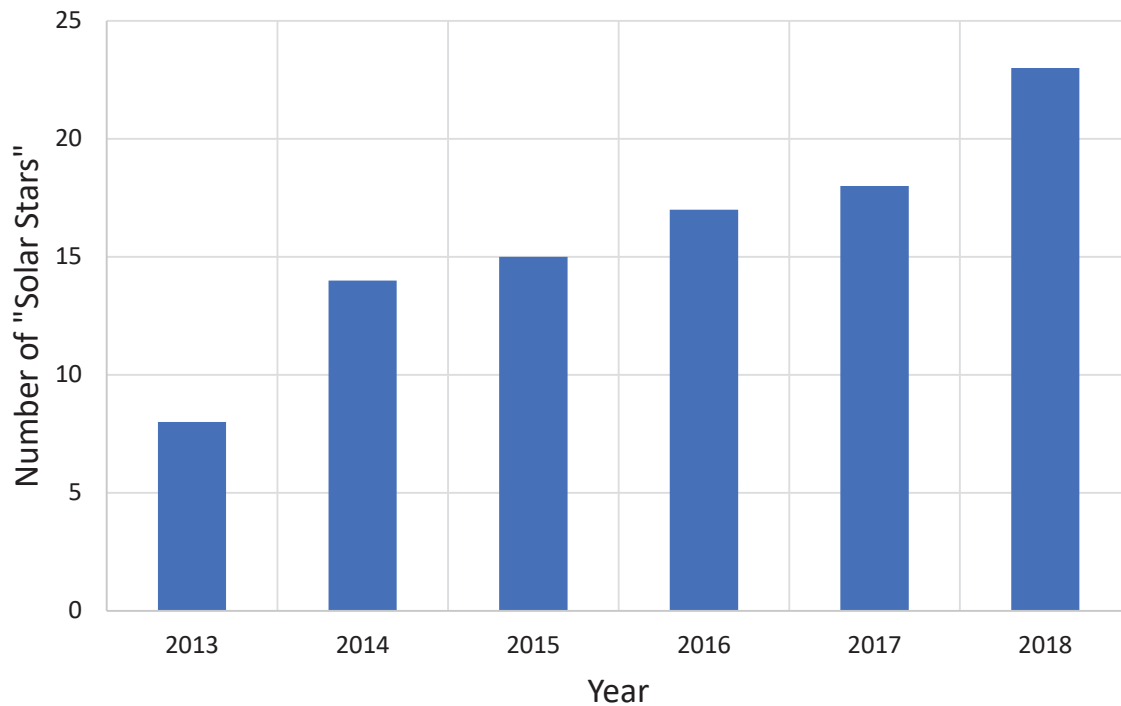


Figure 2: The Number of “Solar Stars” (Cities with >50W of Solar PV per Capita) in Each Edition of *Shining Cities*



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

In 2013, only eight of the cities surveyed for this report had enough solar PV capacity per capita to be ranked as “Solar Stars,” but now 23 cities have earned the title.

Honolulu ranks first among the surveyed cities in solar PV capacity per person, with nearly three times as much solar PV capacity per capita as the next highest ranked city, San Diego. San Jose, Burlington, Vermont, and Las Vegas are also in the top five cities for installed solar PV capacity per person and Hartford, Connecticut, rose four places to make the “Solar Stars” list for the first time this year.

Table 1. The “Solar Stars” (Cities with 50 or More Watts of Solar PV per Person, End of 2018)

Per Capita Rank	City	State	Per Capita Solar PV Installed (Watts-DC/person) [†]	Change in Per Capita Rank 2017 to 2018	Total Solar PV Installed (MW-DC)	Total Solar PV Rank
1	Honolulu	HI	646.4	0	226.5	4
2	San Diego	CA	247.5	0	351.4	2
3	San Jose	CA	194.9	0	201.7	5
4	Burlington	VT	187.3	+1	7.9	37
5	Las Vegas	NV	162.2	+1	104.1	9
6	Phoenix	AZ	145.3	+1	236.2	3
7	Indianapolis	IN	143.5	-3	123.8	8
8	Riverside	CA	138.3	+1	45.3	16
9	Denver	CO	129.6	-1	91.4	10
10	Albuquerque	NM	128.9	+2	72.0	11
11	Salt Lake City	UT	126.9	-1	25.5	21
12	San Antonio	TX	123.6	-1	186.9	7
13	New Orleans	LA	107.3	0	42.2	18
14	Los Angeles	CA	105.0	+1	419.9	1
15	Washington	DC	91.7	+2	63.6	12
16	Newark	NJ	88.6	0	25.3	22
17	Sacramento*	CA	84.4	-3	42.3	17
18	Charleston	SC	75.5	N/A	10.2	34
19	Jacksonville	FL	62.1	+2	55.4	13
20	San Francisco	CA	57.8	-2	51.1	14
21	Boston	MA	54.6	-2	37.4	19
22	Austin*	TX	53.2	+1	50.6	15
23	Hartford	CT	50.1	+4	6.2	42

* Due to an improvement in methodology or data sourcing for this city, total and per capita solar PV capacity reported in this table are not directly comparable with estimates for this city in previous editions of this report. See Appendix B for details on specific cities.

† Throughout the report, includes all solar PV capacity (rooftop and utility-scale solar installations) within the city limits of each city. Does not include solar power installed in the extraterritorial jurisdictions of cities, even those installed by or under contract to municipal utilities. See Methodology for an explanation of how these rankings were calculated. See Appendix B for city-specific sources of data.

“Solar Leaders” have between 25 and 50 watts of solar PV installed per person. These cities come from across the country and those with strong policies are rising toward the rank of “Solar Stars.” Portland, Maine, and Boise, Idaho, both rose at least five places in this ranking during 2018.

Table 2. The “Solar Leaders” (Cities with 25 to 50 Watts of Solar PV per Person, End of 2018)

Per Capita Rank	City	State	Per Capita Solar PV Installed (Watts-DC/person) [†]	Change in Per Capita Rank 2017 to 2018	Total Solar PV Installed (MW-DC)	Total Solar PV Rank
24	Portland	OR	48.2	-4	31.2	20
25	Portland	ME	48.0	+7	3.2	55
26	Buffalo	NY	48.0	0	12.4	31
27	Wilmington	DE	47.0	-5	3.3	54
28	Columbia	SC	46.2	+2	6.1	43
29	Providence	RI	41.4	0	7.5	38
30	Kansas City*	MO	39.0	-5	19.1	24
31	Manchester	NH	36.9	+2	4.1	50
32	St. Louis	MO	35.0	-4	10.8	32
33	Tampa	FL	32.9	+1	12.7	30
34	Boise	ID	30.9	+5	7.0	39

* Due to an improvement in methodology or data source for this city, total and per capita solar PV capacity reported in this table are not directly comparable with estimates for this city in previous editions of this report. See Appendix B for details on specific cities.

The “Solar Builders” are cities with between 5 and 25 watts of installed solar PV capacity per person. This diverse group includes cities that have a history of solar energy leadership as well as cities that have only recently experienced significant solar energy development. Houston, New York City and Louisville, Kentucky, have all worked their way up in the rankings considerably during 2018.

Table 3. The “Solar Builders” (Cities with 5 to 25 Watts of Solar PV per Person, End of 2018)

Per Capita Rank	City	State	Per Capita Solar PV Installed (Watts-DC/person)	Change in Per Capita Rank 2017 to 2018	Total Solar PV Installed (MW-DC)	Total Solar PV Rank
35	Seattle	WA	24.9	-4	18.1	25
36	New York	NY	23.2	+4	200.0	6
37	Raleigh*	NC	22.3	-13	10.4	33
38	Baltimore	MD	22.0	-2	13.5	29
39	Minneapolis*	MN	22.0	-4	9.3	36
40	Cincinnati	OH	20.2	-3	6.1	45
41	Charlotte	NC	19.7	0	16.9	27
42	Orlando	FL	19.6	0	5.5	46
43	Jackson*	MS	16.4	-5	2.7	56
44	Pittsburgh	PA	15.8	-1	4.8	47
45	Richmond	VA	14.9	+2	3.4	53
46	Atlanta	GA	12.5	-1	6.1	44
47	Memphis	TN	10.0	-1	6.5	40
48	Des Moines	IA	9.4	+2	2.0	58
49	Cleveland	OH	9.1	-1	3.5	52
50	Houston	TX	9.0	+8	20.9	23
51	Philadelphia	PA	8.8	0	13.9	28
52	Milwaukee	WI	7.4	+2	4.4	49
53	Dallas	TX	7.2	-9	9.6	35
54	Columbus	OH	7.1	-2	6.3	41
55	Nashville*	TN	6.6	-6	4.4	48
56	Chicago	IL	6.3	-3	17.1	26
57	Louisville	KY	5.7	+3	3.6	51
58	Charleston	WV	5.7	-3	0.3	66

* Due to an improvement in methodology or data source for this city, total and per capita solar PV capacity reported in this table are not directly comparable with estimates for this city in previous editions of this report. See Appendix B for details on specific cities.

The “Solar Beginners” are 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 yet to experience much solar energy development.

Table 4. The “Solar Beginners” (Cities with Less than 5 Watts of Solar PV per Person, End of 2018)

Per Capita Rank	City	State	Per Capita Solar PV Installed (Watts-DC/person)	Change in Per Capita Rank 2017 to 2018	Total Solar PV Installed (MW-DC)	Total Solar PV Rank
59	Billings	MT	4.6	-2	0.5	65
60	Wichita*	KS	4.6	-4	1.8	60
61	Anchorage	AK	4.4	+2	1.3	62
62	Miami	FL	4.3	-1	2.0	59
63	Cheyenne	WY	4.1	-4	0.3	67
64	Birmingham	AL	4.0	+3	0.9	63
65	Oklahoma City*	OK	3.3	-3	2.1	57
66	Detroit	MI	2.2	-2	1.5	61
67	Omaha	NE	1.2	-2	0.5	64
68	Fargo	ND	0.9	-2	0.1	68
69	Virginia Beach*	VA	0.2	-1	0.1	69

* Due to an improvement in methodology or data source for this city, total and per capita solar PV capacity reported in this table are not directly comparable with estimates for this city in previous editions of this report. See Appendix B for details on specific cities.

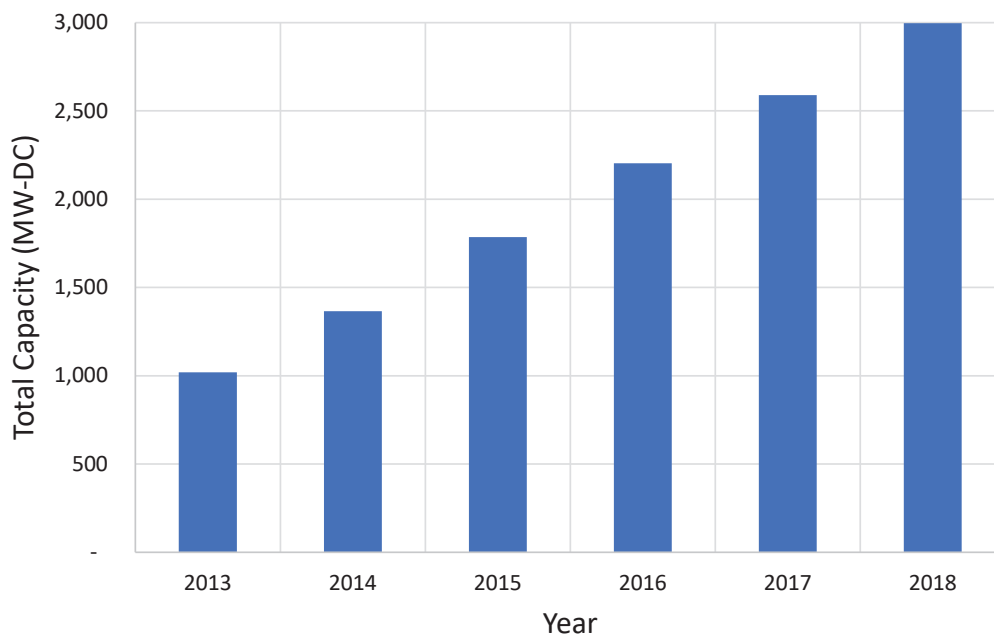
The Top 20 Shining Cities Have More Solar Power than the Entire U.S. in 2010

Cities that lead the nation in total installed solar PV capacity come from all regions of the U.S. The top 20 cities in our report for total solar PV capacity host nearly 3 GW of solar PV capacity – more solar power than the entire country had

installed at the end of 2010.³⁶ **Despite making up only 0.1 percent of the nation’s land area, these cities contain over 4 percent of U.S. solar PV capacity.**³⁷

Of the 57 cities surveyed in all six editions of this report, 79 percent more than doubled their total installed solar PV capacity between 2013 and 2018.

Figure 3: Total Solar PV Capacity of The 57 Cities Included in All Six Editions of *Shining Cities**



* The solar PV capacities for some individual cities are not directly comparable year to year due to changes in data source or methodology.

One-third of the surveyed cities more than quadrupled their installed solar PV capacity over that period, and more than 20 percent increased their capacity more than five-fold.

In 2018, Los Angeles defended its title as the leading city for total installed solar PV capacity – a title the city has held from 2013 to 2015 and in 2017, after briefly being topped by San Diego in 2016.

Figure 4. U.S. Cities by Total Installed Solar PV Capacity, End of 2018 (MW)

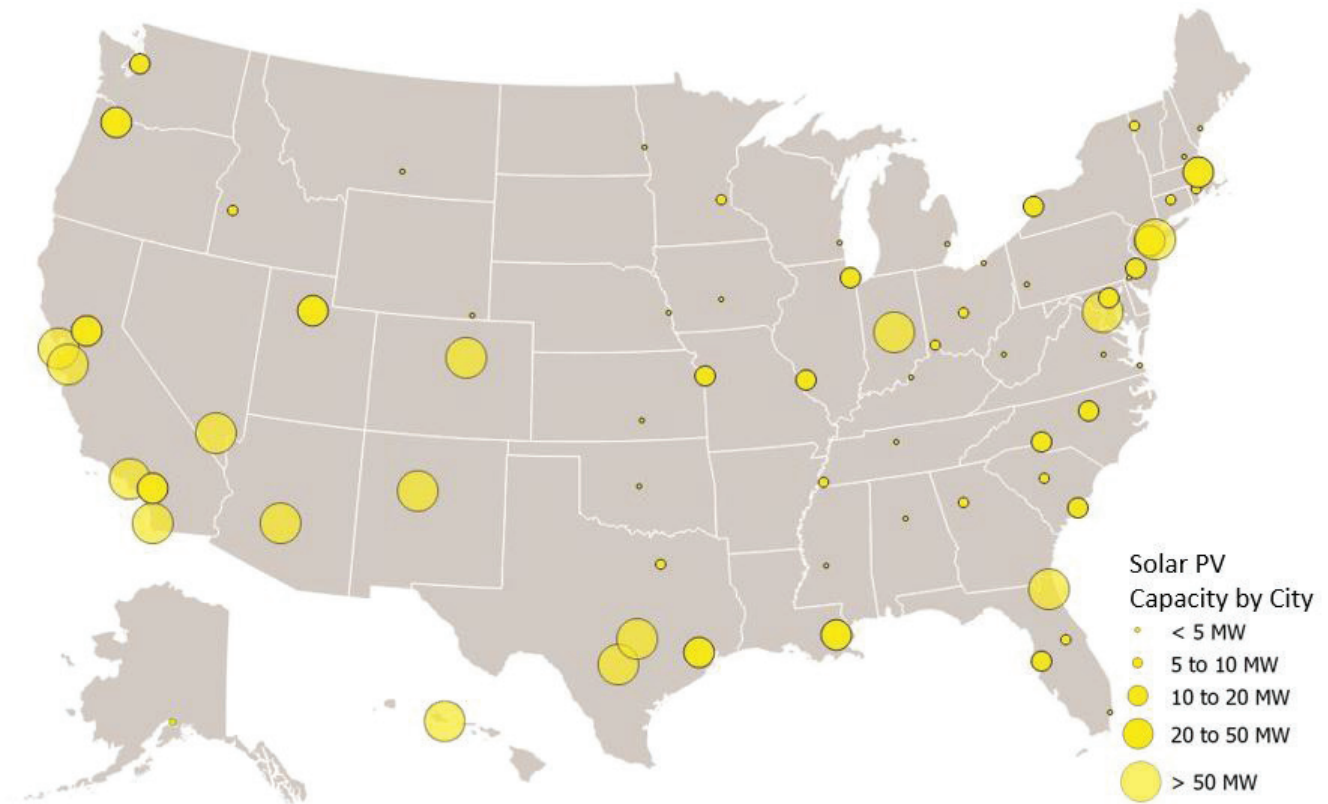


Table 5. Top 20 Solar Cities by Total Installed Solar PV Capacity, End of 2018

Total Solar PV Rank	City	State	Total Solar PV Installed (MW-DC)	Rooftop Solar PV Potential on Small Buildings (MW) [†]	Per Capita Rank	Per Capita Solar PV Installed (Watts-DC/person)
1	Los Angeles	CA	419.9	5,444	14	105.0
2	San Diego	CA	351.4	2,219	2	247.5
3	Phoenix	AZ	236.2	2,981	6	145.3
4	Honolulu	HI	226.5	N/A	1	646.4
5	San Jose	CA	201.7	1,639	3	194.9
6	New York	NY	200.0	1,277	36	23.2
7	San Antonio	TX	186.9	3,721	12	123.6
8	Indianapolis	IN	123.8	N/A	7	143.5
9	Las Vegas	NV	104.1	946	5	162.2
10	Denver	CO	91.4	677	9	129.6
11	Albuquerque	NM	72.0	1,252	10	128.9
12	Washington	DC	63.6	344	15	91.7
13	Jacksonville	FL	55.4	1,715	19	62.1
14	San Francisco	CA	51.1	672	20	57.8
15	Austin*	TX	50.6	1,443	22	53.2
16	Riverside	CA	45.3	612	8	138.3
17	Sacramento*	CA	42.3	777	17	84.4
18	New Orleans	LA	42.2	1,277	13	107.3
19	Boston	MA	37.4	341	21	54.6
20	Portland	OR	31.2	1,397	24	48.2

* Due to an improvement in methodology or data source for this city, total and per capita solar PV capacity reported in this table are not directly comparable with estimates for this city in previous editions of this report. See Appendix B for details on specific cities.

† Reflects the maximum technical solar PV capacity that could be installed on appropriate small building rooftops in each city. These figures were calculated by the U.S. Department of Energy (DOE): U.S. DOE, Energy Efficiency & Renewable Energy State & Local Energy Data, available at apps1.eere.energy.gov/sled/#. Data were unavailable for cities with “N/A” listed.

Every Region of the United States Has Leading Solar Cities

Cities in every region of the country have taken leadership in adopting solar energy. Table 6 lists the top two cities in each region with the most installed solar PV capacity per city resident. For this analysis, we used regional designations from the U.S. Census, grouping some regions together for more logical comparisons.³⁸ We compared cities in the following regions: Pacific, Mountain, North Central, South Central, South Atlantic and the Northeast.

In the Pacific region, **Honolulu** leads with 646.4 watts of solar PV capacity installed per person. Other regional leaders include **Indianapolis** for the North Central region (143.5 watts/person), **Las Vegas** for the Mountain region (162.2 watts/person), **San Antonio** for the South Central region (123.6 watts/person), **Burlington, Vermont**, for the Northeast region (187.3 watts/person) and **Washington, D.C.** for the South Atlantic region (91.7 watts/person).

Figure 5. Top Two Cities in Each Region Ranked by Solar PV Capacity Installed per Person, End of 2018

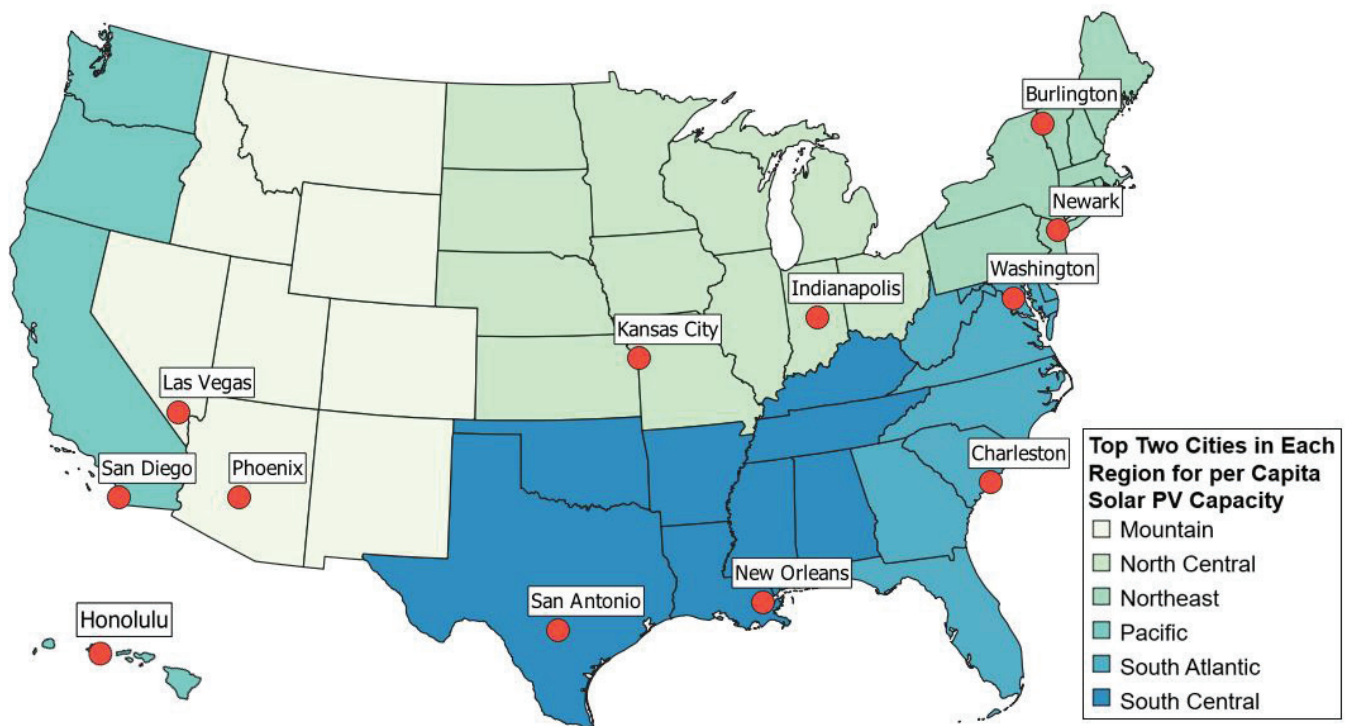


Table 6. Top Two Cities in Each Region Ranked by Solar PV Capacity Installed per Person, End of 2018

Regional Per Capita Rank	City	State	Region	Per Capita Solar PV Installed (Watts-DC/person)	Total Solar PV Installed (MW-DC)
1	Burlington	VT	Northeast	187.3	7.9
2	Newark	NJ	Northeast	88.6	25.3
1	Washington	DC	South Atlantic	91.7	63.6
2	Charleston	SC	South Atlantic	75.5	10.2
1	San Antonio	TX	South Central	123.6	186.9
2	New Orleans	LA	South Central	107.3	42.2
1	Indianapolis	IN	North Central	143.5	123.8
2	Kansas City*	MO	North Central	39.0	19.1
1	Las Vegas	NV	Mountain	162.2	104.1
2	Phoenix	AZ	Mountain	145.3	236.2
1	Honolulu	HI	Pacific	646.4	226.5
2	San Diego	CA	Pacific	247.5	351.4

* Due to an improvement in methodology or data source for this city, total and per capita solar PV capacity reported in this table are not directly comparable with estimates for this city in previous editions of this report. See Appendix B for details on specific cities.

Smaller Cities and Towns Are Going Big on Solar Energy

Progress in adopting solar energy is not limited to the nation’s largest cities; many smaller cities and towns are going big on solar energy, too. These communities have followed a variety of paths in developing solar energy. In some cases, local governments have played an important role in jumpstarting local solar growth by setting goals for installed solar capacity, implementing solar-friendly laws, and expediting zoning and permitting processes. Some communities with municipal utilities have had an even more direct influence on solar power adoption by establishing ambitious requirements for solar energy adoption and by

implementing effective financial incentives. Some places have taken steps to increase the use of solar energy on public facilities, while, in other communities, strong state policies are driving local solar power growth. As demonstrated in the following examples, cities can most effectively promote solar power when local, state and utility policies work together.

- **Santa Fe, New Mexico:** In 2014, the city of Santa Fe set a goal to become carbon neutral by 2040 and the city government is leading by example in achieving that goal.³⁹ The city has installed enough renewable energy on city facilities to provide 25 percent of its electricity needs, including over 4.8 MW of solar energy.⁴⁰ The city as a

whole had 19 MW of solar PV capacity installed as of the end of 2018 and 225 watts per person – that’s more solar PV per capita than any city on our list other than Honolulu and San Diego.⁴¹

- **Tallahassee, Florida:** At 30 MW of solar PV capacity, Tallahassee, Florida has enough solar PV capacity per capita (157 watts per person) to be ranked as a leading “Solar Star.”⁴² This is thanks in large part to the 28 MW solar farm contracted by the city. Through the Tallahassee Solar program, residents and businesses were allowed to enroll to purchase their electricity from the solar farm at a fixed rate for the next 20 years. The 2,000 slots for this program filled up so quickly that the city is continuing it for another solar farm it plans to build.⁴³ The City of Tallahassee also offers low interest loans for a variety of energy efficiency measures and clean energy systems, including solar PV.⁴⁴
- **Trenton, New Jersey:** Trenton, New Jersey, has almost 16 MW of solar PV capacity installed and 186 watts per person.⁴⁵ That’s more than all but three of the major cities on our list – Honolulu, San Diego and Burlington. Trenton is already a leader in solar energy and, thanks to a new program in New Jersey, Trenton’s solar PV capacity is likely to increase. New Jersey is developing the Community Solar Energy Pilot Program that will add a minimum of 225 MW of new solar capacity in the state from which residents who cannot install their own solar panels will be able to purchase electricity and receive net metering credits.⁴⁶ This program will be available to and benefit residents across New Jersey.
- **Worcester, Massachusetts:** During the summer of 2017, Worcester opened the largest municipally-owned solar farm in New England, built on top of a former landfill.⁴⁷ The city expects that the project will pay for itself in six years and save the city \$60 million over the 30 years it is expected to operate.⁴⁸ Multiple nonprofits in Worcester have

also invested in solar energy systems to save money, stabilize their costs, and put more of their funding toward their work.⁴⁹ In total, Worcester has 28 MW of solar PV capacity installed and 150 watts per person, enough to be ranked as a “Solar Star.”⁵⁰

- **El Paso, Texas:** In 2017, El Paso earned the Gold designation from SolSmart, a program funded by the U.S. Department of Energy (DOE) Solar Energy Technologies Office (SETO) (formerly known as the SunShot Initiative), which recognizes local governments that lower barriers to installing solar energy systems.⁵¹ El Paso received the award for creating an online checklist to guide residents through the process of adopting solar panels; for streamlining its permitting process so that permit applications for small solar PV systems are now turned around in just 24 hours; and for consolidating the number of inspections required for new solar installations.⁵²

In 2018, El Paso Electric expanded its community solar option, which allows residents to purchase solar power from large installations and share in their financial benefits. The city expects to add 2,500 new members through this expansion.⁵³ At the end of 2018, almost 38 MW of solar PV capacity were installed in El Paso.⁵⁴ That is 55 watts per person, enough to rank El Paso a “Solar Star” on our list.⁵⁵

- **Ypsilanti, Michigan:** In 2005, a group of volunteers worked to secure a grant from the state of Michigan to install solar panels on the local Ypsilanti Food Co-op.⁵⁶ Inspired by the work of these volunteers, the small city of roughly 20,000 residents set a goal to install 1,000 solar roofs by 2020.⁵⁷ To achieve that goal, Ypsilanti took many steps to encourage its residents to install solar panels, including by creating a streamlined permitting process for small PV systems.⁵⁸ In 2017, the U.S. DOE SETO designated Ypsilanti SolSmart

Gold for these efforts. At the end of 2018, there were nearly 700 kW of solar PV capacity installed in Ypsilanti and over 32 watts per person – enough to rank Ypsilanti as a “Solar Leader.”⁵⁹

Fossil Fuel Interests and Some Utilities Are Dimming the Promise of Solar Energy

The fossil fuel industry sees the rapid growth of solar energy as a threat. The rise of consumer interest in installing solar panels is also changing how utilities operate. In resistance to these changes, fossil fuel interests and some utilities are pushing to slow solar energy’s growth across the country through various measures, such as rolling back net metering and implementing solar-specific charges on electric bills. The following are just a few examples of cities whose solar energy markets may be hurt going forward by recent policy changes:

- **Detroit:** In June 2018, the state of Michigan replaced its net metering policy with an “avoided cost tariff.”⁶⁰ Under this new structure, solar energy owners will be credited at a lower rate for the energy they supply to the grid.⁶¹ Solar energy advocates warn that when Nevada implemented a similar change in 2015, the solar energy market there was significantly stunted and they point out that net metering was reinstated in Nevada due to pushback from citizens.⁶² Immediately after Michigan replaced net metering, a group of state legislators began drafting a set of bills to reinstate the policy.⁶³
- **Indianapolis:** In May 2017, the state of Indiana passed a law that will gradually reduce the length of time that solar customers can participate in net metering, based on when they enrolled in the program.⁶⁴ The law will also decrease the net metering compensation rate for new customers starting in 2022, and will allow utilities to stop accepting new net metering customers once

they make up 1.5 percent of the utility’s peak summer load.⁶⁵

Even though there will still be net metering benefits for those who install solar panels before 2022, the bill received so much media attention that the rate at which citizens are installing solar panels has dropped.⁶⁶ The City of Indianapolis has supported the growth of solar energy for many reasons, citing that it improves public and environmental health and reduces the burden of household energy costs for its residents.⁶⁷ Indianapolis has been one of the top cities, both in terms of total and per capita solar PV capacity, in all six editions of this report, but has been passed by several cities in the most recent editions of the report. According to solar energy business owners, the state’s recent law regarding net metering will hurt this once thriving solar energy market going forward.⁶⁸

- **Jacksonville, Florida:** JEA, formerly known as Jacksonville Electric Authority, which provides power to Jacksonville and other areas of Florida, officially removed net metering in April 2018. The utility has committed to install a large amount of its own solar PV capacity, but rolling back net metering will deter homeowners and businesses from adopting solar energy systems themselves.⁶⁹ Local residents are now suing JEA for net metering to be restored.⁷⁰

Solar Energy Has Enormous Potential in U.S. Cities

While the exponential growth of solar power has already delivered enormous benefits to communities across the U.S., America is still far from tapping its full solar energy potential. A National Renewable Energy Laboratory (NREL) study estimated that building rooftops alone are technically capable of hosting 1,118 GW of solar PV capacity.⁷¹ That is enough solar energy to cover the annual electric-

ity needs of more than 121 million homes – about as many as currently exist in the U.S.⁷² Cities also have the potential to develop solar energy on larger buildings and in utility-scale installations on open land – adding significantly to the clean energy they can provide to the grid.

Even the nation’s leading solar cities have immense untapped solar energy potential – collectively the cities surveyed in this report have developed less than 5 percent of the solar PV capacity they could install on their small building rooftops alone. The NREL study found that this year’s leading city for total solar PV capacity, Los Angeles, could host up to 5,000 MW of solar PV capacity on the rooftops of its small buildings alone. That’s over 12 times the solar power capacity the city currently has installed. Washington, D.C. has developed more of its solar PV potential than any other city on this list and its total solar PV capacity is only 18.5 percent of what the city could accommodate on its small building rooftops. Of the cities on this list, 33 could install 50 times as much solar PV as they currently have installed in total on their small building rooftops alone. San Antonio and Houston, for example, could each accommodate more than 3,500 MW of solar PV capacity on rooftops in the city and Phoenix, Chicago, San Diego, Oklahoma City and Dallas could all install at least 2,000 MW of solar PV capacity.⁷³

Policy Recommendations

U.S. cities, as centers of population growth and energy consumption, must lead the way in building a grid powered by 100 percent clean, renewable energy. Many cities have already experienced the havoc that global warming can cause through severe weather, drought, increased heavy precipitation and intense heat waves. Increasing solar energy capacity will be critical to reduce greenhouse gas emissions, and create a more resilient and reliable energy system.

Research shows that solar energy policies – more than the availability of sunshine – dictate which states are succeeding in adopting solar energy and which are not.⁷⁴ The most effective policies facilitate the wide-scale adoption of small-scale solar energy systems on homes, businesses, and other institutions, while also speeding up the deployment of utility-scale solar energy projects. Policy-makers at every level of government – federal, state and local – have an important role to play in making sure solar energy continues to thrive.

Portland General Electric via Flickr, CC BY-ND 2.0.



Rooftop solar panels on a school in Portland, Oregon.

Local governments should:

- **Set ambitious goals for solar energy adoption** – The cities that are leading in solar energy adoption are not doing so by chance. The second highest-ranked city for total installed solar PV capacity, San Diego, has set the ambitious goal of generating 100 percent of its electricity from renewable sources by 2035.⁷⁵ A large part of the city’s plan to achieve this goal is implementing programs that promote solar energy.⁷⁶ Over 100 cities in the United States have adopted ambitious 100 percent renewable electricity goals and Burlington, Vermont – one of the top-ranked cities for solar capacity per capita – is one of five communities in the U.S. that have already achieved this goal.⁷⁷
- **Implement solar access ordinances** – These critical protections guard homeowners’ right to generate electricity from the sunlight that hits their property, regardless of the actions of their neighbors or homeowners’ associations. Local governments should also offer clear zoning regulations that allow solar energy installations on residential and commercial rooftops by right, which will help unlock new solar markets in communities.⁷⁸ The Delaware Valley Regional Planning Commission in the Philadelphia area offers a model ordinance guide that cities can apply to their own local laws.⁷⁹
- **Promote or require new homes to install solar panels and/or be zero net-energy** – Solar energy is most efficient and cost-effective when it is designed into new construction from the start. State and local governments have adopted policies to require new homes or commercial buildings to have solar power or to be designed so that solar energy can be easily installed.⁸⁰ As part of its 2019 Building Energy Efficiency Standards, the entire state of California will require new single-family homes and multi-family homes of up to three stories to install solar PV panels starting in 2020.⁸¹ These standards will help increase renewable energy production in California, maximize residen-

tial solar energy’s benefits to the electric grid, cut greenhouse gas emissions, and save money. The City of Tucson requires that new single-family homes or duplexes either include a solar energy system or be pre-outfitted so that future solar PV and hot water systems can be easily installed.⁸² Other jurisdictions set goals for new net-zero energy homes that employ energy efficiency and renewable energy technologies such that they produce as much energy as they consume. By pairing solar energy with highly efficient construction, rooftop solar panels can meet a higher percentage of home energy needs.⁸³

- **Make permitting, zoning and inspection processes easy, quick and affordable** – The “soft” costs of solar energy, such as costs related to zoning and permitting and acquiring customers, now make up about two-thirds of the total cost of residential solar energy systems.⁸⁴ Reducing fees, making permitting rules clear and readily available, speeding up the permitting process, and making inspections convenient for property owners can significantly lower the barriers for residents to switch to solar energy.⁸⁵ Making sure that permitting and inspection staff are properly trained is key to achieving these goals. The SolSmart program, run by the U.S. DOE Solar Energy Technologies Office (SETO) (formerly known as the SunShot Initiative), helps cities fund programs that work toward these goals, such as Kansas City’s work to make its solar energy permitting process available online and to update its building code to be friendlier to solar energy.⁸⁶ Vote Solar has also laid out a series of best practices that local governments can follow to ensure that their permitting process is solar-friendly.⁸⁷
- **Expand access to solar energy** – Statewide and citywide financing programs can make solar energy available to all residents, including low-income households, nonprofits, small businesses and apartment dwellers. Community solar programs like the Community Solar Energy Pilot Program in

New Jersey allow groups of residents to purchase electricity from the same larger solar installation and share in the net metering or other financial benefits of the installation. Similarly, “solarize” bulk purchasing programs lower the costs of solar energy so that more residents can participate.⁸⁸ Power purchase agreements (PPAs) utilized in New York and elsewhere can allow apartment occupants and others who cannot install their own solar systems to purchase and benefit from solar energy. The Property Assessed Clean Energy Program (PACE) allows local and state governments to loan money to home and business owners for energy improvements. This program includes an option to tie a loan for a solar installation to the property itself so that it is transferred to the new owner if the property is sold. This program has been key for property owners who are concerned that they may move before they recoup their investment in a solar installation.

- ***Consider creating a municipal utility or community choice aggregation system in communities where investor-owned utilities are unwilling to cooperate to promote solar power*** – Municipally owned utilities have been among the nation’s leaders in promoting solar power. While many investor-owned utilities have been willing partners with cities in promoting solar energy, cities served by less supportive utilities may want to consider forming a municipal utility in order to gain greater control over their local electric grids. The City of Minneapolis, for example, partnered with the two investor-owned utilities serving the city in 2014 in order to meet its goal of reducing emissions by 30 percent by 2025. However, the partnership came only after there was a push for municipalization.⁸⁹ Community choice aggregation is another option available in some states in which the city, rather than the utility, is responsible for purchasing power, but unlike a municipal utility, the private utility still maintains the power lines and provides customer service.⁹⁰

- ***Install solar panels on public buildings*** – Local governments can promote solar energy by installing solar panels and signing solar PPAs for public buildings. For example, there are about 5,500 K-12 schools across the country that have installed solar energy systems with a combined capacity of 910 MW.⁹¹ In 2016, the city government of Albuquerque committed to generate 25 percent of its energy needs from solar energy by 2025 and the city government of Las Vegas now gets 100 percent of its energy from renewable sources.⁹² Not only do solar installations on public buildings save governments money on their electricity bills, but they also serve as a public example of a smart, clean energy investment.
- ***Implement policies that support energy storage, electric vehicle charging and microgrids*** – Technological advances are enabling solar energy to be used in new ways, including to charge electric vehicles (EVs) and to be integrated with energy storage technologies and other energy resources in microgrids. Local governments should alter their ordinances to allow these technologies to be easily adopted.⁹³ See the Environment America Research & Policy Center reports *Making Sense of Energy Storage* and *Plugging In* for guidance on making policies friendly to energy storage and EV adoption.⁹⁴
- ***Support and push for strong state policies*** – State policies can have a large impact on a city’s ability to expand solar energy, so it is important that cities work together to support and push their state governments to enact the policies recommended below.

State governments should:

- ***Set or increase renewable energy targets for utilities and adopt specific requirements for solar energy adoption*** – States should adopt or increase mandatory “renewable portfolio standards” (RPS) that move toward 100 percent renewable energy

and include solar carve-outs that require a significant and growing share of that state's electricity to come from the sun. States should also ensure that utilities implement solar power wherever it is a beneficial solution for meeting electricity needs, including as part of utilities' long-term resource plans. Honolulu, the current leader for per capita solar PV capacity, benefits from Hawaii's law that requires utilities to generate 100 percent of the electricity they sell from renewable sources by 2045.⁹⁵

- **Adopt and preserve strong statewide interconnection and net metering policies** – Strong interconnection policies ensure that individuals and businesses can easily connect their solar PV systems to the electric grid and move seamlessly between producing their own electricity and using electricity from the grid. It is critical that states ensure that their interconnection process is straightforward and efficient in order to make it easy to “go solar.”⁹⁶ Net metering policies ensure that solar panel owners are appropriately credited for the electricity that they export to the grid. In states without strong net metering programs, carefully implemented CLEAN contracts (also known as feed-in tariffs) and value-of-solar payments can play an important role in ensuring that consumers receive fair crediting for solar energy, so long as the payments fully account for the benefits of solar energy and are sufficient to spur participation in the market.
- **Ensure that electric rate designs encourage solar adoption** – Many utilities are now adding or increasing charges on electric bills that can cause solar customers to pay almost as much on their energy bills as traditional customers, despite using far less energy from the utility over the course of a month.⁹⁷ These include demand charges, which are based on the period of time in the month (typically a 15-60 minute interval) in which a customer used the most power from the grid.

Some utilities also assign higher fixed monthly charges to solar customers specifically.⁹⁸ State governments and utility regulators should reject proposals such as this that discourage customers from switching to solar energy.

- **Establish policies that expand solar energy access to all residents** – According to NREL, 49 percent of Americans either don't own a home, have shading on their homes, or cannot afford a solar energy system.⁹⁹ Policies such as virtual or aggregate net metering and community solar allow low-income households, renters and apartment dwellers to collectively own solar energy systems and share in the net metering credits they generate. Enabling PACE financing can also expand access to solar power.
- **Establish public benefits charges on utility bills or other sustainable financing mechanisms for solar energy** – These practices help fund solar energy for low-income households, non-profits, small businesses, and local municipalities to ensure that all categories of customers have access to the benefits of solar power.
- **Enable third-party sales of electricity** – Financing rooftop solar energy systems through third-party electricity sales significantly lowers the up-front cost of installing solar PV systems for commercial and residential consumers. States should allow companies that install solar panels to sell electricity to their customers without subjecting them to the same regulations as large utilities.
- **Implement, maintain or increase tax credits, rebates and grants for solar energy installations** – Tax credits, rebates and grants are powerful incentives that have made solar energy a financial option for many more Americans.
- **Implement policies that support energy storage, electric vehicle charging and microgrids** – State governments should design policies that facilitate

the transition from an electric 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. Such state policies should support the expansion of energy storage technologies, electric vehicle charging and microgrids.¹⁰⁰

Strong and thoughtful federal policies can promote solar power, make it more accessible, and lay an important foundation on which state and local policy initiatives can be built. Among the key policy approaches that the **federal government** should take are the following:

- **Continue and expand financing support for solar energy** – In December 2015, the federal government extended the Investment Tax Credit, a key incentive program for solar energy, with a gradual phase down after 2019.¹⁰¹ The federal government should maintain federal tax credits for solar energy, but also add provisions as necessary to enable nonprofit organizations, housing authorities and others who are not eligible for tax credits to benefit from those incentives. The tax credit should also be expanded to apply to energy storage systems, such as home batteries.
- **Support research to drive solar power innovations** – The U.S. DOE SETO has served as a rallying point for federal efforts to encourage the expansion of solar energy.¹⁰² SETO and similar initiatives facilitate solar energy adoption by investigating

the best ways to integrate solar energy into the grid, deliver solar energy more efficiently and cost-effectively, and lower market barriers to solar energy. The federal government should also invest in research and development of energy storage to ease the integration of renewable energy into the grid, to strengthen cities’ grids in the face of extreme weather, and to unlock the other benefits of energy storage.¹⁰³

- **Lead by example** – The federal government consumes vast amounts of energy and manages thousands of buildings. If the federal government were to put solar installations on every possible rooftop, it would set a strong example for what can be done to harness the limitless and pollution-free energy of the sun. The Department of Defense, for example, is committed to obtain one-quarter of its energy from renewable sources by 2025 and had already installed more than 253 MW of solar energy capacity by 2016.¹⁰⁴
- **Expand access to solar energy** – Federal agencies such as the Department of Housing and Urban Development and the Department of Education should work to expand access to solar energy for subsidized housing units and schools by installing solar power on those facilities or enabling community solar projects. Programs designed to provide fuel assistance to low-income customers, such as the Low-Income Home Energy Assistance Program, should be expanded to include solar energy.

Methodology

There is no uniform national data source that tracks solar energy by municipality. As a result, the data for this report come from a variety of sources – municipal and investor-owned utilities, city and state government agencies, operators of regional electric grids and non-profit organizations. These data sources have varying levels of comprehensiveness, with varying levels of geographic precision, and often use different methods of quantifying solar PV capacity (e.g., AC versus DC capacity).

We have worked to obtain data that are as comprehensive as possible, resolve discrepancies in various methods of estimating solar PV capacity, 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, use reasonable methods to estimate the proportion of a given area's solar energy capacity that exists within a particular city. Much of the data is provided by utilities, the majority of which only track grid-tied solar energy systems, so most cities lack data for non-grid-tied installations. 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 inconsistencies in the data can affect individual cities'

rankings. The full list of sources of data for each city is provided in Appendix B along with the details of any data analyses performed.

For some cities, our most recent solar capacity estimates are not directly comparable to previous estimates listed in earlier editions of *Shining Cities*. In some cases, this is because some solar energy systems installed toward the end of the year were not reported by the time we collected data. Also, for some cities, we were able to obtain more specific and complete data this year. In a few cases, our current estimate is lower than previous estimates for the same city, due either to inconsistencies in the data reported to us by the cities or improved precision in assigning solar installations to cities. For an explanation of individual discrepancies, see Appendix B.

Selecting the Cities

The cities evaluated in this report consist of the principal cities in the top 50 most populous Metropolitan Statistical Areas in the United States according to the U.S. Census Bureau and the most populous cities in each state not represented on that list.¹⁰⁵ In South Carolina, Charleston now has a larger population than Columbia, but we decided to continue to include Columbia in our analysis for continuity with previous reports. For a complete list of cities, see Appendix A.

We were unable to find reliable data for Little Rock, Arkansas. Also, Sioux Valley Energy, the utility that serves Sioux Falls, South Dakota, reported that there is no solar capacity installed in Sioux Falls' city limits connected to their grid.¹⁰⁶

Converting from AC Watts to DC Watts

Jurisdictions and agencies often use different methods of quantifying solar PV 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 power a home or business or enter the electric grid. Solar capacity reported in AC watts accounts for the loss of energy that occurs when DC is converted to AC.¹⁰⁷

We attempted to convert all data to DC watts for the sake of accurate comparison across cities. 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 estimate of solar capacity from AC to DC megawatts (MW), we used the default DC to AC ratio in

NREL's *PV Watts Calculator* of 1.2.¹⁰⁸ A different conversion factor was used in the 2014 to 2017 versions of this reports, which affects year to year comparisons for some cities.

Using Data on Solar PV Installations by Zip Code to Estimate Capacity within City Limits

In some cases, we were only able to find data on solar PV capacity installed by zip code in an urban area. Zip codes do not necessarily conform to city boundaries; in many cases, a zip code will fall partially inside and partially outside of a city's boundaries. For these cities, we used QGIS software and U.S. Census Bureau cartographic boundary files for Zip Code Tabulation Areas and city boundaries to determine the share of the area in each zip code that fell within municipal boundaries. We then multiplied the total solar PV capacity within each zip code by that portion to approximate solar capacity installed within city limits. Details of calculations for cities for which a geospatial analysis was performed are given in Appendix B.

Appendix A: Solar Energy in Major U.S. Cities

City	State	Population	Per Capita Rank	Per Capita Solar PV Installed (Watts-DC/person)	Total Solar PV Rank	Total Solar PV Installed (MW-DC) [†]	Rooftop Solar PV Potential on Small Buildings (MW) [‡]
Albuquerque	NM	558,545	10	128.9	11	72.0	1,252
Anchorage	AK	294,356	61	4.4	62	1.3	N/A
Atlanta	GA	486,290	46	12.5	44	6.1	496
Austin*	TX	950,715	22	53.2	15	50.6	1,443
Baltimore	MD	611,648	38	22.0	29	13.5	460
Billings	MT	109,642	59	4.6	65	0.5	229
Birmingham	AL	210,710	64	4.0	63	0.9	537
Boise	ID	226,570	34	30.9	39	7.0	428
Boston	MA	685,094	21	54.6	19	37.4	341
Buffalo	NY	258,612	26	48.0	31	12.4	512
Burlington	VT	42,239	4	187.3	37	7.9	44
Charleston	SC	134,875	18	75.5	34	10.2	267
Charleston	WV	47,929	58	5.7	66	0.3	153
Charlotte	NC	859,035	41	19.7	27	16.9	1,356
Cheyenne	WY	63,624	63	4.1	67	0.3	150
Chicago	IL	2,716,450	56	6.3	26	17.1	2,775
Cincinnati	OH	301,301	40	20.2	45	6.1	510
Cleveland	OH	385,525	49	9.1	52	3.5	734
Columbia	SC	133,114	28	46.2	43	6.1	252
Columbus	OH	879,170	54	7.1	41	6.3	1,905

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City	State	Population	Per Capita Rank	Per Capita Solar PV Installed (Watts-DC/person)	Total Solar PV Rank	Total Solar PV Installed (MW-DC) [†]	Rooftop Solar PV Potential on Small Buildings (MW) [‡]
Dallas	TX	1,341,075	53	7.2	35	9.6	2,083
Denver	CO	704,621	9	129.6	10	91.4	677
Des Moines	IA	217,521	48	9.4	58	2.0	351
Detroit	MI	673,104	66	2.2	61	1.5	1,256
Fargo	ND	122,359	68	0.9	68	0.1	151
Hartford	CT	123,400	23	50.1	42	6.2	118
Honolulu	HI	350,395	1	646.4	4	226.5	N/A
Houston	TX	2,312,717	50	9.0	23	20.9	4,605
Indianapolis	IN	863,002	7	143.5	8	123.8	N/A
Jackson*	MS	166,965	43	16.4	56	2.7	422
Jacksonville	FL	892,062	19	62.1	13	55.4	1,715
Kansas City*	MO	488,943	30	39.0	24	19.1	971
Las Vegas	NV	641,676	5	162.2	9	104.1	946
Los Angeles	CA	3,999,759	14	105.0	1	419.9	5,444
Louisville	KY	621,349	57	5.7	51	3.6	N/A
Manchester	NH	111,196	31	36.9	50	4.1	159
Memphis	TN	652,236	47	10.0	40	6.5	1,439
Miami	FL	463,347	62	4.3	59	2.0	751
Milwaukee	WI	595,351	52	7.4	49	4.4	849
Minneapolis*	MN	422,331	39	22.0	36	9.3	359
Nashville*	TN	667,560	55	6.6	48	4.4	N/A
New Orleans	LA	393,292	13	107.3	18	42.2	1,277
New York	NY	8,622,698	36	23.2	6	200.0	1,277
Newark	NJ	285,154	16	88.6	22	25.3	154
Oklahoma City*	OK	643,648	65	3.3	57	2.1	2,089
Omaha	NE	466,893	67	1.2	64	0.5	876
Orlando	FL	280,257	42	19.6	46	5.5	583

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City	State	Population	Per Capita Rank	Per Capita Solar PV Installed (Watts-DC/person)	Total Solar PV Rank	Total Solar PV Installed (MW-DC) [†]	Rooftop Solar PV Potential on Small Buildings (MW) [‡]
Philadelphia	PA	1,580,863	51	8.8	28	13.9	884
Phoenix	AZ	1,626,078	6	145.3	3	236.2	2,981
Pittsburgh	PA	302,407	44	15.8	47	4.8	388
Portland	OR	647,805	24	48.2	20	31.2	1,397
Portland	ME	66,882	25	48.0	55	3.2	109
Providence	RI	180,393	29	41.4	38	7.5	196
Raleigh*	NC	464,758	37	22.3	33	10.4	674
Richmond	VA	227,032	45	14.9	53	3.4	401
Riverside	CA	327,728	8	138.3	16	45.3	612
Sacramento*	CA	501,901	17	84.4	17	42.3	777
Salt Lake City	UT	200,544	11	126.9	21	25.5	276
San Antonio	TX	1,511,946	12	123.6	7	186.9	3,721
San Diego	CA	1,419,516	2	247.5	2	351.4	2,219
San Francisco	CA	884,363	20	57.8	14	51.1	672
San Jose	CA	1,035,317	3	194.9	5	201.7	1,639
Seattle	WA	724,745	35	24.9	25	18.1	1,081
St. Louis	MO	308,626	32	35.0	32	10.8	632
Tampa	FL	385,430	33	32.9	30	12.7	783
Virginia Beach*	VA	450,435	69	0.2	69	0.1	860
Washington	DC	693,972	15	91.7	12	63.6	344
Wichita*	KS	390,591	60	4.6	60	1.8	803
Wilmington	DE	71,106	27	47.0	54	3.3	72

* Due to an improvement in methodology or data source for this city, total and per capita solar PV capacity reported in this table are not directly comparable with estimates for this city in previous editions of this report. See Appendix B for details on specific cities.

† Includes all solar PV capacity (rooftop and utility-scale solar installations) within the city limits of each city. Does not include solar power installed in the extraterritorial jurisdictions of cities, even those installed by or under contract to municipal utilities. See Methodology for an explanation of how these rankings were calculated. See Appendix B for city-specific sources of data.

‡ Reflects the maximum technical solar PV capacity that could be installed on appropriate small building rooftops in each city. These figures were calculated by the U.S. Department of Energy (DOE): U.S. DOE, Energy Efficiency & Renewable Energy State & Local Energy Data, available at apps1.eere.energy.gov/sled/#. Data were unavailable for cities with "N/A" listed.

Appendix B: Detailed Sources and Methodology by City

Albuquerque, New Mexico

The Public Service Company of New Mexico (PNM), which serves the city of Albuquerque, provided us total solar PV capacity installed within Albuquerque as of December 31, 2018 in DC watts.¹⁰⁹

Anchorage, Alaska

The two electric utilities serving the city of Anchorage, Chugach Electric and Anchorage Municipal Light and Power, provided us with summary information on the solar PV capacity installed in Anchorage's city limits as of the end of 2018 in AC watts, which we converted to DC watts.¹¹⁰

Atlanta, Georgia

Southface (www.southface.org) provided us with a list of solar PV installations in DeKalb and Fulton counties through December 31, 2018 with latitude and longitude coordinates for each installation.¹¹¹ Some data were provided in AC watts, which we converted to DC watts and some were provided in DC watts. We used this information to map the installations using the open source software QGIS to isolate solar capacity within the city limits of Atlanta. Southface maintains a map of "Georgia Energy Data" at www.GeorgiaEnergyData.org.

Austin, Texas

Austin Energy, which serves the city of Austin, provided us with a spreadsheet of all of the solar PV installations within Austin as of December 31, 2018

in DC watts.¹¹² The data provided for previous editions of this report extended beyond city limits and required geographic analysis, which led to underestimates of total capacity. Therefore, this year's data is not directly comparable with previous years'. We note that our final figure does not account for solar power generated by the 30 MW Webberville solar farm, which is located in the village of Webberville.¹¹³ While the Webberville Solar Farm supplies solar energy to Austin residents through a PPA with Austin Energy, the facility is located outside of city limits and therefore was excluded from the analysis.

Baltimore, Maryland

Data for solar PV installations in Baltimore, as of December 2018, were downloaded in a spreadsheet called "Renewable Generators Registered in GATS" through the Generation Attribute Tracking System (GATS), an online database administered by the PJM regional transmission organization.¹¹⁴ To focus on solar PV installations within Baltimore city limits, we filtered by primary fuel type "SUN" for "Baltimore City." Data were assumed to be in DC watts.

Billings, Montana

Northwestern Energy, the utility serving Billings, provided the grid-tied solar PV capacity installed within the city limits of Billings in DC watts as of December 31, 2018.¹¹⁵

Birmingham, Alabama

Alabama Power, the electric utility serving the city, provided an estimate of installed solar PV capacity in Birmingham through the end of 2018 in AC watts, which we converted to DC watts.¹¹⁶ This figure is for Birmingham zip codes, some of which extend outside of city limits, so it is possible that projects outside of city limits are included.

Boise, Idaho

Idaho Power, the electric utility serving Boise, provided the total solar PV capacity of net-metered installations tied to their grid within Boise as of December 31, 2018 in DC watts.¹¹⁷

Boston, Massachusetts

We downloaded the “Solar PV Systems in MA Report” spreadsheet from the Massachusetts Clean Energy Center online Product Tracking System.¹¹⁸ We filtered this list to installations in the city of Boston. This list may be incomplete because it only includes systems that are fully registered with the Production Tracking System. The total solar PV capacity installed within Boston may, therefore, be higher than the reported figure.

Buffalo, New York

Data on solar PV installations in the city of Buffalo were obtained from the Open NY Database in the spreadsheet “Solar Electric Programs Reported by NYSERDA: Beginning 2000.”¹¹⁹ We summed the capacities, which are listed in DC watts, for installations completed before December 31, 2018 in the city of Buffalo.

Burlington, Vermont

A list of solar PV installations in Burlington at the end of 2018 was provided by the City of Burlington’s Electric Department.¹²⁰ Capacity figures were listed in AC watts, which we converted to DC watts.

Charleston, South Carolina

We estimated the amount of solar PV capacity in Charleston based on county-level data provided by the South Carolina Energy Office.¹²¹ We multiplied the total capacity of solar PV installations within Charleston County by the 2017 proportion of Charleston County housing units located in the city of Charleston to estimate what percentage of this capacity fell within city limits.¹²² Data were provided in AC watts, which we converted to DC watts. Data were only available through July 31, 2018, so it is likely that systems were added after that date and, thus, that solar PV capacity in Charleston was higher by December 31, 2018. This is the first year that Charleston, South Carolina has been included in the Shining Cities report series because its population is now greater than Columbia, South Carolina.

Charleston, West Virginia

American Electric Power Company, the utility serving Charleston, West Virginia, provided us with the total solar PV capacity installed within Charleston through the end of 2018 in AC watts, which we converted to DC watts.¹²³

Charlotte, North Carolina

Duke Energy, the utility serving Charlotte provided us with the total solar PV capacity installed within Charlotte through the end of 2018 in AC watts, which we converted to DC watts.¹²⁴

Cheyenne, Wyoming

Black Hills Corporation, the electric utility serving Cheyenne provided us with total solar PV capacity installed within Cheyenne as of December 31, 2017 in AC watts, which we converted to DC watts.¹²⁵ We were unable to obtain an updated figure as of December 31, 2018, so the capacity in Cheyenne at the end of 2018 may be higher than the figure listed.

Chicago, Illinois

Commonwealth Edison, the electric utility serving the city of Chicago, provided us with the total solar PV capacity tied to their grid within Chicago as of December 31, 2018 in AC watts, which we converted to DC watts.¹²⁶

Cincinnati, Ohio

Duke Energy, the electric utility serving Cincinnati, provided the total solar PV capacity installed within Cincinnati through the end of 2018 in AC watts, which we converted to DC watts.¹²⁷

Cleveland, Ohio

We downloaded a spreadsheet of approved renewable energy generating facilities in Ohio from the Public Utilities Commission of Ohio's (PUCO) web page.¹²⁸ We filtered this spreadsheet for solar PV installations approved in 2018 in Cuyahoga County, Ohio. To determine which systems were installed in Cleveland, we looked up the corresponding Case Reference numbers on PUCO's website, which included addresses associated with the installations.¹²⁹ The Cuyahoga County Department of Sustainability provided us with the total solar PV capacity of residential co-op systems installed within Cleveland during 2018 in DC watts.¹³⁰ These installations did not include the Cleveland systems on the PUCO list, so we added both figures to the total capacity installed within Cleveland at the end of 2017 to estimate the total capacity at the end of 2018. Neither data source is comprehensive, so it is possible that solar PV capacity in Cleveland at the end of 2018 is higher than the figure listed.

Columbia, South Carolina

We estimated the amount of solar PV capacity in Columbia based on county-level data provided by the South Carolina Energy Office.¹³¹ We multiplied the total capacity of solar PV installations within Richland County by the 2017 proportion of Richland County housing units located in Columbia to estimate the percentage of this capacity that is within city limits.¹³² Data

were provided in AC watts, which we converted to DC watts. Data were only available through July 31, 2018, so it is likely that the total solar PV capacity in Columbia was higher as of December 31, 2018.

Columbus, Ohio

The City of Columbus Department of Public Utilities provided solar PV capacity installed in Columbus as of December 31, 2018 in DC watts.¹³³

Dallas, Texas

The office of Representative Rafael Anchia, serving Dallas' District 103 in the Texas House Legislature, provided us with the solar PV capacity in Dallas as of December 31, 2018.¹³⁴ This figure was supplied by Oncor Electric Delivery, the utility serving Dallas in AC watts, which we converted to DC watts. The figure Oncor supplied this year is lower than the figure they supplied last year and the utility was unable to explain the difference.

Denver, Colorado

The Denver Public Health & Environment Department provided us with data on the installed solar PV capacity within Denver as of the end of 2017, which was provided by Xcel Energy, the utility serving Denver.¹³⁵ These data were listed in DC watts. The City and County of Denver Community Planning and Development Department provided us with a spreadsheet of all permits issued in the city relating to solar PV systems, with capacities listed in DC watts.¹³⁶ We filtered these data for new solar PV installation permits completed during 2018. Not all permits contained capacity information, so we multiplied the number of permits without capacity data by the median capacity of all installations with capacity data listed. We added the estimated total capacity of installations added during 2018 to the cumulative capacity at the end of 2017 to estimate the total solar PV capacity installed within Denver as of December 31, 2018. The figure (91 MW) was an estimate – the actual total solar PV capacity installed in Denver as of December 31, 2017 was 92 MW DC.

Des Moines, Iowa

MidAmerican Energy, the energy company that serves Des Moines, provided us with the total solar PV capacity installed within the city limits of Des Moines as of December 31, 2018 in AC watts.¹³⁷ We converted this figure to DC watts.

Detroit, Michigan

Total solar PV capacity added within the city of Detroit during 2018 was provided by DTE Energy, the electric utility serving the city.¹³⁸ Data were provided in AC watts, which we converted to DC watts and added to the total solar PV capacity in Detroit as of December 31, 2017.

Fargo, North Dakota

An estimate of solar PV capacity in Fargo as of December 31, 2018 was provided in DC watts by Cass County Electric Cooperative, which serves part of the city.¹³⁹ Xcel Energy, which serves the other part of Fargo, did not have any known solar PV capacity installed in its service area to report.¹⁴⁰

Hartford, Connecticut

The Connecticut Public Utilities Regulatory Authority provided a spreadsheet listing solar facilities approved under Connecticut's Renewable Portfolio Standard in both AC and DC watts.¹⁴¹ We totaled all solar PV capacity installed in the city of Hartford through December 31, 2018 and converted all AC figures to DC watts.

Honolulu, Hawaii

We estimated the amount of solar PV capacity in Honolulu from county-level data released by Hawaiian Electric, the company serving the County of Honolulu (which is coterminous with the island of O'ahu).¹⁴² Within the island of O'ahu, the census designated place "Urban Honolulu CDP" is the area most comparable with other U.S. cities. We multiplied the total capacity of solar PV installations within Honolulu County by the portion of its land area that falls within Urban Hono-

lulu CDP to estimate the solar PV capacity in Honolulu. Solar PV capacity figures are reported to Hawaiian Electric in a combination of AC and DC watts and we were unable to determine which values were given in which units, so we made the conservative assumption that all data were listed in DC watts.

Houston, Texas

Total installed solar PV capacity within Houston city limits as of December 31, 2018 was provided by Center-Point Energy, the electric utility serving the city, in AC watts, which we converted to DC watts.¹⁴³

Indianapolis, Indiana

Indianapolis Power and Light, the electric utility serving Indianapolis provided us with the total installed solar PV capacity within the city limits of Indianapolis as of December 31, 2018 in AC watts, which we converted to DC watts.¹⁴⁴

Jackson, Mississippi

Entergy Mississippi, the electric utility serving Jackson, provided us with the total installed solar PV capacity in Jackson, Mississippi as of December 31, 2018.¹⁴⁵ Previously, the data were thought to be AC watts, but this year Entergy confirmed they are in DC watts. Therefore, this figure is not comparable with those in previous years' reports.

Jacksonville, Florida

JEA, formerly Jacksonville Electric Authority, the utility serving Jacksonville, provided us with a spreadsheet of net-metered solar PV installations within their service area through December 31, 2018 in DC watts.¹⁴⁶ We filtered these data for installations within the city of Jacksonville.

Kansas City, Missouri

Kansas City Power & Light, the electric utility serving the city, provided total installed solar PV capacity within Kansas City at the end of 2018 in DC watts.¹⁴⁷

Las Vegas, Nevada

The City of Las Vegas' Office of Sustainability provided us with the total solar PV capacity within the city of Las Vegas through December 31, 2018 in AC watts, which we converted to DC watts.¹⁴⁸

Los Angeles, California

Total installed solar PV capacity in Los Angeles as of December 31, 2018 was provided by the Los Angeles Department of Water and Power, the city's municipal electric utility, in AC watts, which we converted to DC watts.¹⁴⁹

Louisville, Kentucky

Louisville Gas & Electric, the electric utility serving Louisville, provided the total solar PV capacity installed in the city as of December 31, 2018 in DC watts.¹⁵⁰

Manchester, New Hampshire

Eversource Energy, the electric utility serving Manchester, provided the solar PV capacity installed within the city limits of Manchester through December 31, 2018 in AC watts, which we converted to DC watts.¹⁵¹

Memphis, Tennessee

Memphis Light, Gas and Water, the city's municipal electric utility, provided total solar PV capacity installed in Memphis as of December 31, 2018 in DC watts.¹⁵²

Miami, Florida

Florida Power & Light (FPL), the municipality serving the city, provided the total solar PV capacity installed within Miami city limits as of December 31, 2018 in DC watts.¹⁵³

Milwaukee, Wisconsin

An estimate of the total capacity of solar PV systems installed in Milwaukee during 2018 was provided by the City of Milwaukee's Environmental Collaboration Office in DC watts.¹⁵⁴ We added this total to Milwaukee's total capacity at the end of 2017 to calculate the city's total solar PV capacity at the end of 2018.

Minneapolis, Minnesota

Xcel Energy, the electric utility serving the city of Minneapolis, provided us with total solar PV capacity installed within the city as of the end of 2018 in DC watts.¹⁵⁵ Xcel reported that the decrease in capacity during 2018 was likely due to decommissioned projects.

Nashville, Tennessee

Nashville Electric Service, the electric utility serving the city of Nashville, provided us with total solar PV capacity installed within the city as of the end of 2018 in DC watts.¹⁵⁶ Previously, Nashville Electric Service erroneously provided data that extended beyond city limits. This year's figure is, therefore, not comparable with the figure published in last year's report.

New Orleans, Louisiana

Entergy New Orleans, the electric utility serving the city of New Orleans, provided us with a total installed solar PV capacity within New Orleans' city limits in DC watts.¹⁵⁷ This figure is current as of as of October 31, 2018, so the solar PV capacity in New Orleans as of the end of 2018 is likely higher than the figure published.

New York, New York

Data on solar PV capacity installed within the city limits of New York as of December 31, 2018 were provided by Consolidated Edison, the utility serving the city, in AC watts, which we converted to DC watts.¹⁵⁸

Newark, New Jersey

The solar PV installations supported by New Jersey's Clean Energy Program (NJCEP) are made available online in the NJCEP Solar Activity Report.¹⁵⁹ We downloaded the data updated through January 31, 2019 and filtered out systems installed during 2019. We filtered for solar installations registered in the city names of "Newark," "Newark City," "Newark N," and "Newrk." We conservatively assumed capacities were in DC watts.

Oklahoma City, Oklahoma

The Oklahoma City Office of Sustainability provided us with the total solar PV capacity of net-metered solar installations in Oklahoma City, which was provided in DC watts by Oklahoma Gas & Electric, the utility serving the city.¹⁶⁰ To this total, we added 1 MW for an installation at a Veteran's Hospital within city limits.¹⁶¹

Omaha, Nebraska

Omaha Public Power District (OPPD), the electric utility serving the city of Omaha, provided us with the total capacity of solar PV systems tied to their grid within Omaha city limits at the end of 2018.¹⁶² OPPD did not know whether the figure was in AC watts or DC watts, so we conservatively assumed DC.

Orlando, Florida

Total solar PV capacity installed within the city of Orlando, as of December 31, 2018 and serviced by the Orlando Utilities Commission (OUC), was provided by OUC in DC watts.¹⁶³

Philadelphia, Pennsylvania

Data were downloaded from the Solar Renewable Energy Certificates PJM-GATS registry, administered by regional electric transmission organization PJM.¹⁶⁴ These data include installations through December 2018 and were filtered for Primary Fuel Type "SUN" and County "Philadelphia," which is coterminous with the city of Philadelphia. Capacities were listed in DC watts.

Phoenix, Arizona

Phoenix is served by two electric utilities, Arizona Public Service (APS) and Salt River Project (SRP). Data from both service territories were provided by the City of Phoenix as of December 31, 2018 in DC watts.¹⁶⁵

Pittsburgh, Pennsylvania

Data for solar PV installations in Allegheny County, Pennsylvania, were downloaded in a spreadsheet called "Renewable Generators Registered in GATS" through the online GATS database administered by

PJM.¹⁶⁶ To focus on solar PV installations, we filtered by primary fuel type "SUN." To estimate the amount of solar capacity installed within the city of Pittsburgh only, we looked up the number of solar installation permits within Pittsburgh completed between 1/1/13 – 12/31/18 (511 installations) on the Pittsburgh Building Eye website.¹⁶⁷ Based on the PJM data, 1,929 installations were completed in Allegheny County during the same time span, leading to the conclusion that 26 percent of Allegheny County solar projects were installed in Pittsburgh during this time. Based on this, we estimated that 26 percent of the total solar PV capacity installed within Allegheny County as of December 31, 2018 was installed within Pittsburgh.

Portland, Maine

Central Maine Power Company, the utility company serving the central and southern areas of Maine, provided us with the total solar PV capacity connected to their grid in Portland through the end of 2018 in DC watts.¹⁶⁸

Portland, Oregon

The City of Portland, Oregon, was unable to provide the current solar PV capacity for Portland, so the capacity as of December 31, 2017 was used. The solar PV capacity in Portland as of December 31, 2018 is therefore likely higher than the figure listed. The city of Portland is served in part by Portland General Electric and in part by Rocky Mountain Power, which operates as Pacific Power in the state of Oregon. Data on solar PV capacity installed by these utilities within Portland city limits through December 31, 2017 were provided by the City of Portland's Bureau of Planning and Sustainability in DC watts.¹⁶⁹

Providence, Rhode Island

Total solar PV capacity within Providence city limits as of December 31, 2018 was provided by the Rhode Island Office of Energy Resources.¹⁷⁰ Figures were given in AC watts, which we converted to DC watts.

Raleigh, North Carolina

The North Carolina Sustainable Energy Association (NCSEA) provided a list of interconnected PV systems for all of Wake County. Some installations' capacities were listed in AC watts, which we converted to DC watts. A few installations did not indicate AC or DC – for these we conservatively assumed DC watts. The list is only current through November 9, 2018, so it is possible that the solar PV capacity in Raleigh at the end of 2018 is higher than the figure listed.¹⁷¹ We used QGIS to determine which installations fell within the city limits of Raleigh. This year's figure is lower than the figure published in last year's report because all installations were previously included and not filtered through GIS analysis.

Richmond, Virginia

The Virginia Department of Minerals, Mines and Energy provided a list of interconnected solar PV systems with service addresses in the city of Richmond through 31 December, 2018. Not all Richmond addresses fall within city limits, so we multiplied the total solar PV capacity within each zip code by the portion of that zip code that falls within city limits. We did this analysis for installations added during 2017 and 2018 and added that total to the total solar PV capacity within Richmond at the end of 2016. We also added a non-net-metered, 60 kW system at Virginia Union University to the total. This system was installed and is owned by Dominion Virginia Power under their Solar Partnership program.¹⁷²

Riverside, California

The total installed solar PV capacity for Riverside as of December 31, 2018 was provided in DC watts by Riverside Public Utilities.¹⁷³

Sacramento, California

The total installed solar PV capacity for Sacramento as of December 31, 2018 was provided by Sacramento Municipal Utility District (SMUD) in AC watts,

which we converted to DC watts.¹⁷⁴ Last year, SMUD reported that the cumulative solar PV capacity in Sacramento at the end of 2017 was 49.8 MW DC, but this year corrected the figure to 33.2 MW DC, indicating that the figure provided last year was likely not constrained to Sacramento's city limits.

Salt Lake City, Utah

The total capacity of solar PV installations in Salt Lake City as of December 31, 2018 was provided by the Salt Lake City Office of Sustainability in DC watts.¹⁷⁵

San Antonio, Texas

CPS Energy, the utility serving San Antonio, provided us with the total residential solar PV capacity in San Antonio as of December 31, 2018 in DC watts, as well as a list of utility-scale solar PV installations in AC watts, which we converted to DC watts and added to the residential total.¹⁷⁶

San Diego, California

San Diego Gas & Electric, the electric utility serving the city, provided us with a figure of total solar PV capacity installed within San Diego as of December 31, 2018 in AC watts, which we converted to DC watts.¹⁷⁷

San Francisco, California

San Francisco's Department of the Environment provided us with the total solar PV capacity installed within San Francisco city limits as of December 2018 in AC watts, which we converted to DC watts.¹⁷⁸

San Jose, California

The City of San Jose provided us with total solar PV capacity installed within the city limits of San Jose as of December 31, 2018 in AC watts, which we converted to DC watts.¹⁷⁹

Seattle, Washington

Seattle City Light, the municipal utility serving the city, was unable to provide data on Seattle's total solar PV capacity at the end of 2018. The figure published is current as of December 31, 2017.¹⁸⁰

St. Louis, Missouri

Ameren Missouri, the utility serving the city of St. Louis, provided us with total solar PV capacity in St. Louis as of December 31, 2018 in DC watts.¹⁸¹

Tampa, Florida

TECO Energy, the electric utility serving the city of Tampa, provided us with the total installed solar PV capacity in Tampa as of December 2018 in DC watts.¹⁸²

Virginia Beach, Virginia

Dominion Energy, the utility serving Virginia Beach, provided us with the total installed solar PV capacity within the Virginia Beach metro area as of December 31, 2018 in AC watts, which we converted to DC watts.¹⁸³ We multiplied this figure by the portion of Virginia Beach metro area's land area that falls within Virginia Beach city limits to estimate the solar PV capacity within Virginia Beach. This figure is lower than the figure published in last year's report, which was for the greater metro area.

Washington, D.C.

Pepco, the utility serving Washington, D.C., provided us with total solar PV capacity installed within the city as of the end of 2018 in AC watts, which we converted to DC watts.¹⁸⁴

Wichita, Kansas

Westar Energy, the electric utility serving Wichita, provided us with the total solar PV capacity of systems interconnected to their grid with Wichita addresses as of December 31, 2018 in DC watts.¹⁸⁵ It is possible that some of these Wichita addresses extend beyond city limits. This year's figure is lower than the figure in last year's report because data were provided in AC watts last year, which we converted to DC watts and this year data were provided directly in DC watts.

Wilmington, Delaware

The Delaware Public Service Commission maintains a List of Certified Eligible Energy Resources. We downloaded the most updated version of this spreadsheet and filtered the list for Fuel Type "SUN" and all Generation Units Locations in "Wilmington."¹⁸⁶ Zip codes were not included so we multiplied the total capacity of systems added during 2018 by the portion of all zip codes' areas that partially fall within Wilmington. We then added this figure to the estimate for cumulative solar PV capacity in Wilmington through 2017. We conservatively assumed the capacities were listed in DC watts.

Appendix C

Texas towns ranked by solar PV capacity per capita as of December 31, 2018. This is not a comprehensive list of all municipalities in Texas.

Per Capita Rank	Town	Population	Solar PV Capacity Per Capita (watts/person)	Total Solar PV Rank	Total Solar PV Capacity (MW-DC)
1	Beasley	663	18,099.5	5	12.0
2	Magnolia	1,442	423.7	14	0.6
3	Rosharon	1,152	361.6	19	0.4
4	Katy	18,282	177.8	7	3.3
5	Richmond	12,064	139.4	9	1.7
6	San Antonio	1,511,946	123.6	1	186.9
7	Damon	552	111.3	40	0.06
8	Humble	15,997	70.3	11	1.1
9	Needville	3,065	61.8	30	0.2
10	Crosby	5,899	61.1	21	0.4
11	El Paso	683,577	55.1	3	37.6
12	Austin	950,715	53.2	2	50.6
13	Brookshire	5,265	44.7	26	0.2
14	Boling	1,271	35.4	46	0.05
15	Manvel	10,115	34.5	22	0.3
16	Highlands	7,522	26.1	29	0.2
17	Bellaire	18,797	26.1	16	0.5
18	Santa Fe	13,442	25.4	23	0.3
19	Fresno	19,069	23.1	17	0.4
20	Pattison	586	20.3	58	0.01
21	Fulshear	10,044	20.0	28	0.2
22	Pinehurst	4,624	18.4	37	0.09
23	Bellville	4,236	13.7	42	0.06
24	Kemah	2,024	12.4	51	0.03
25	Mont Belvieu	5,946	11.6	39	0.07
26	Rosenberg	37,661	11.6	18	0.4
27	Missouri City	74,497	11.0	13	0.8
28	Montgomery	970	10.3	62	0.01
29	Alvin	26,474	9.1	25	0.2
30	Cypress	174,489	9.0	10	1.6
31	Hedwig Village	2,668	9.0	52	0.02
32	Houston	2,312,717	8.9	4	20.6

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Per Capita Rank	Town	Population	Solar PV Capacity Per Capita (watts/person)	Total Solar PV Rank	Total Solar PV Capacity (MW-DC)
33	Pearland	119,940	8.9	12	1.1
34	Huffman	12,397	8.8	34	0.1
35	Hockley	23,088	7.5	32	0.2
36	Dallas	1,341,075	7.2	6	9.6
37	Kendleton	386	6.5	66	0.003
38	Dayton	7,969	6.5	44	0.05
39	Baytown	76,804	6.4	15	0.5
40	Galveston	50,497	5.8	24	0.3
41	Corpus Christi	325,605	5.3	8	1.7
42	El Lago	2,740	5.2	55	0.01
43	La Porte	35,371	5.2	31	0.2
44	Clute	11,634	5.1	41	0.06
45	Bacliff	8,619	5.0	48	0.04
46	Deer Park	33,891	4.1	33	0.1
47	Liverpool	519	3.9	67	0.002
48	Dickenson	20,359	3.9	38	0.08
49	Kingwood	63,942	3.4	27	0.2
50	Lake Jackson	27,473	3.2	35	0.09
51	Richwood	3,907	3.0	60	0.01
52	Danbury	1,769	3.0	64	0.01
53	Friendswood	29,839	2.9	36	0.09
54	Galena Park	10,989	2.8	49	0.03
55	Angleton	19,544	2.7	43	0.05
56	Pasadena	153,520	2.4	20	0.4
57	Meadows Place	4,621	2.4	61	0.01
58	Freeport	12,169	2.3	50	0.03
59	Hitchcock	7,900	2.1	53	0.02
60	Hempstead	7,659	1.9	54	0.01
61	Jersey Village	7,929	1.5	57	0.01
62	Channelview	38,289	1.3	45	0.05
63	East Bernard	2,335	1.1	65	0.003
64	La Marque	16,766	0.7	58	0.01
65	League City	104,903	0.4	47	0.04
66	Porter	25,769	0.2	63	0.01
67	Atascocita	65,844	0.2	56	0.01

The solar PV capacity in Corpus Christi as of December 31, 2018 was provided by American Electric Company (AEP), the utility serving the city in DC watts.¹⁸⁷ Data sources for Austin, Dallas, Houston and San Antonio can be found in Appendix B. The solar PV capacity in El Paso at the end of 2018 was provided by El Paso Electric Company, the utility serving the city in DC watts.¹⁸⁸ The solar PV capacities for all other cities were provided by CenterPoint Energy, the utility serving those cities, as of December 31, 2018 in AC watts, which we converted to DC watts.¹⁸⁹

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