Shining Cities 2017

How Smart Local Policies Are Expanding Solar Power in America

ENVIRONMENT MINNESOTA
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Cover photos: View of downtown Honolulu, Hawaii, with solar photovoltaic system mounted on a house, Mana Photo; maintenance worker inspecting solar panels on rooftop, bikeriderlondon; Solar panels on the Chicago Center for Green Technology, Flickr user Josh Koonce.

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Executive Summary

Solar power grew at a record-breaking pace in 2016. The United States now has 42 gigawatts (GW) of solar photovoltaic (PV) energy capacity, enough to power 8.3 million homes and reduce carbon dioxide emissions by 52.3 million metric tons annually.[1] Hundreds of thousands of Americans, especially in our cities, have invested in their own solar panels or solar projects in their communities 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 as well.

As of the end of 2016, 20 cities—representing just 0.1 percent of U.S. land area—accounted for 5 percent of

Figure ES-1: U.S. Cities by Cumulative Installed Solar PV Capacity, End of 2016

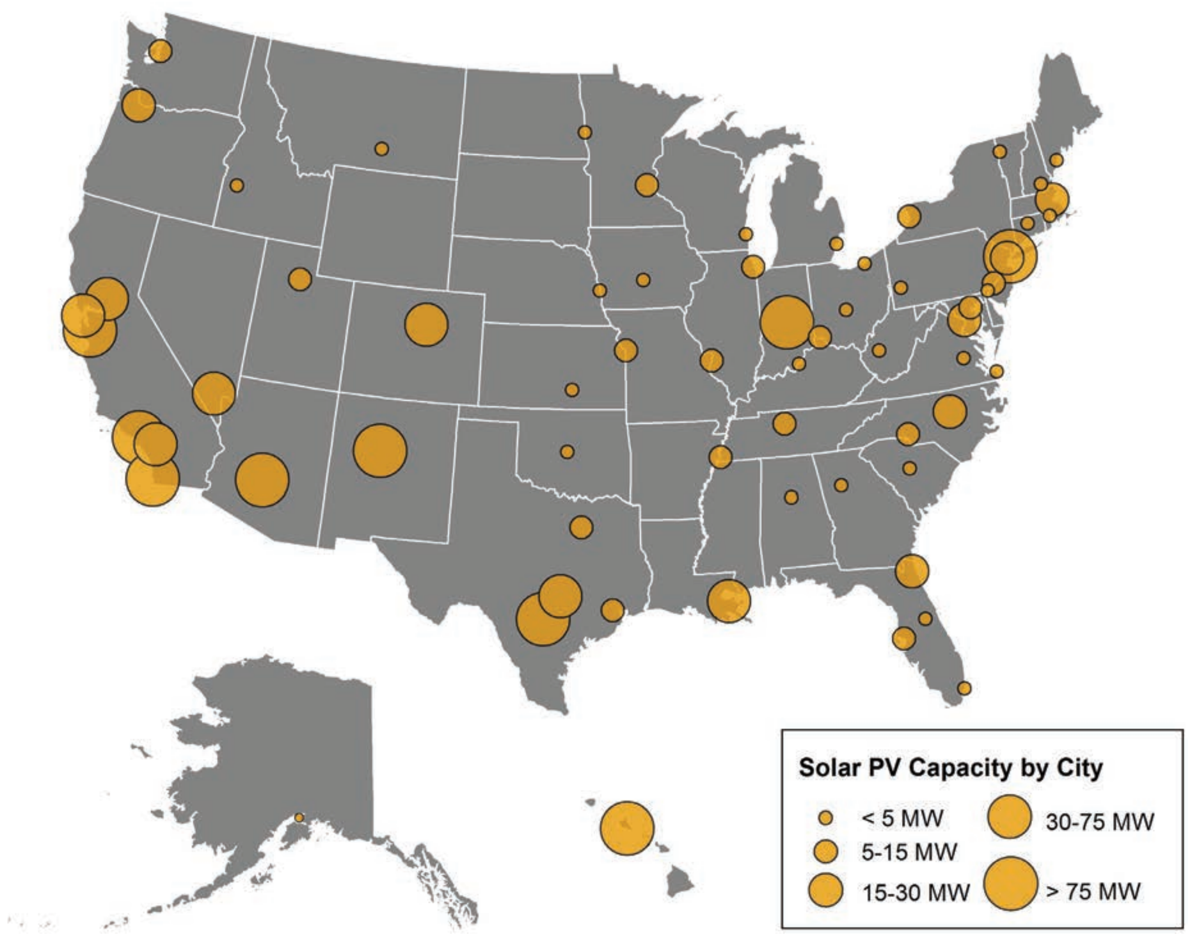

Table ES-1: Top 20 Solar Cities by Total Installed Solar PV Capacity, End of 2016*

City	State	Total Solar PV Installed (MW-DC)	Total Solar PV Rank	Per Capita Solar PV Installed (Watts-DC)	Per Capita Rank	Rooftop Solar PV Potential for Small Buildings (MW) †
San Diego	CA	303	1	217.6	2	2,219
Los Angeles	CA	267	2	67.1	15	5,444
Honolulu	HI	175	3	495.2	1	N/A
San Jose	CA	174	4	169.1	3	1,639
Phoenix	AZ	165	5	105.6	7	2,981
Indianapolis	IN	127	6	148.5	4	N/A
New York	NY	117	7	13.7	38	1,277
San Antonio	TX	117	8	79.5	12	3,721
Albuquerque	NM	82	9	146.1	5	1,252
Las Vegas	NV	75	10	119.6	6	946
San Francisco	CA	46	11	53.5	17	672
Denver	CO	45	12	66.4	16	677
Sacramento	CA	40	13	81.4	10	777
New Orleans	LA	37	14	95.0	9	1,277
Riverside	CA	32	15	98.9	8	612
Austin‡	TX	31	16	33.0	24	1,443
Portland	OR	27	17	43.0	19	1,397
Washington, D.C.	DC	25	18	37.5	21	344
Jacksonville	FL	25	19	29.0	27	1,715
Newark	NJ	22	20	78.1	13	154

** This includes all solar PV capacity (rooftop and utility-scale solar installations) within the city limits of each city. It 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.*

† This 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. Data were unavailable for cities with "N/A" listed.[4]

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

U.S. solar PV capacity. **These 20 cities have nearly 2 GW of solar PV capacity—nearly as much solar power as the entire country had installed at the end of 2010.**[2]

San Diego leads the nation in total installed solar PV capacity among the 66 cities surveyed in this report, replacing Los Angeles, which had been the national leader for the past three years. Honolulu rose from sixth place for total PV capacity at the end of 2015 to third place at the end of 2016. (See Table ES-1.)

Even the cities that have seen the greatest solar success still have vast amounts of untapped solar energy potential. For instance, San Diego has developed less than 14 percent of its technical potential for solar energy on small buildings.[3] **To take advantage of that potential, and move America toward an economy powered by 100 percent renewable energy, city, state and federal governments should adopt a series of pro-solar policies.**

The cities with the most solar PV installed per capita are the "Solar Stars"—cities with 50 or more watts of installed solar PV capacity per person. These cities have experienced dramatic growth in solar energy and are setting the pace nationally for solar energy development. **Honolulu, San Diego, San Jose, Indianapolis and Albuquerque are the top five cities in the nation for installed solar PV capacity per person**. (See Figure ES-2 and Table ES-2.) Notable changes in 2016 include:

- Albuquerque rose to be among the top five cities for per capita solar PV capacity from being ranked 16th in 2013.
- Riverside, California rose to 8th place in 2016 from 20th in 2014.
- Between 2015 and 2016, San Francisco joined the ranks of the Solar Stars.
- In 2014, only eight of the surveyed cities had enough solar PV capacity per person to be ranked "Solar Stars," but at the end of 2016, 17 cities had solar capacity exceeding 50 watts per person.

Regional leaders for per capita solar capacity include **Honolulu** in the Pacific region, **Albuquerque** in the Mountain region, **Indianapolis** in the North Central region, **New Orleans** in the South Central region, **Wilmington, Delaware,** in the South Atlantic region and **Burlington, Vermont,** in the Northeast region.

America's leading solar cities are those that have adopted strong pro-solar public policies or that are located within states that have done so. Among the most important steps cities have taken to advance solar energy are:

- **Leading by example:** The city government of Las Vegas now receives 100 percent of its energy needs from renewable sources, including a total of 6.2 MW of solar electric capacity. Solar energy systems are installed on 40 public buildings, including community centers, fire stations and parks. A 3.3 MW solar plant

Figure ES-2: U.S. Cities by Installed Solar PV Capacity per Capita, End of 2016 (Watts Per Person)

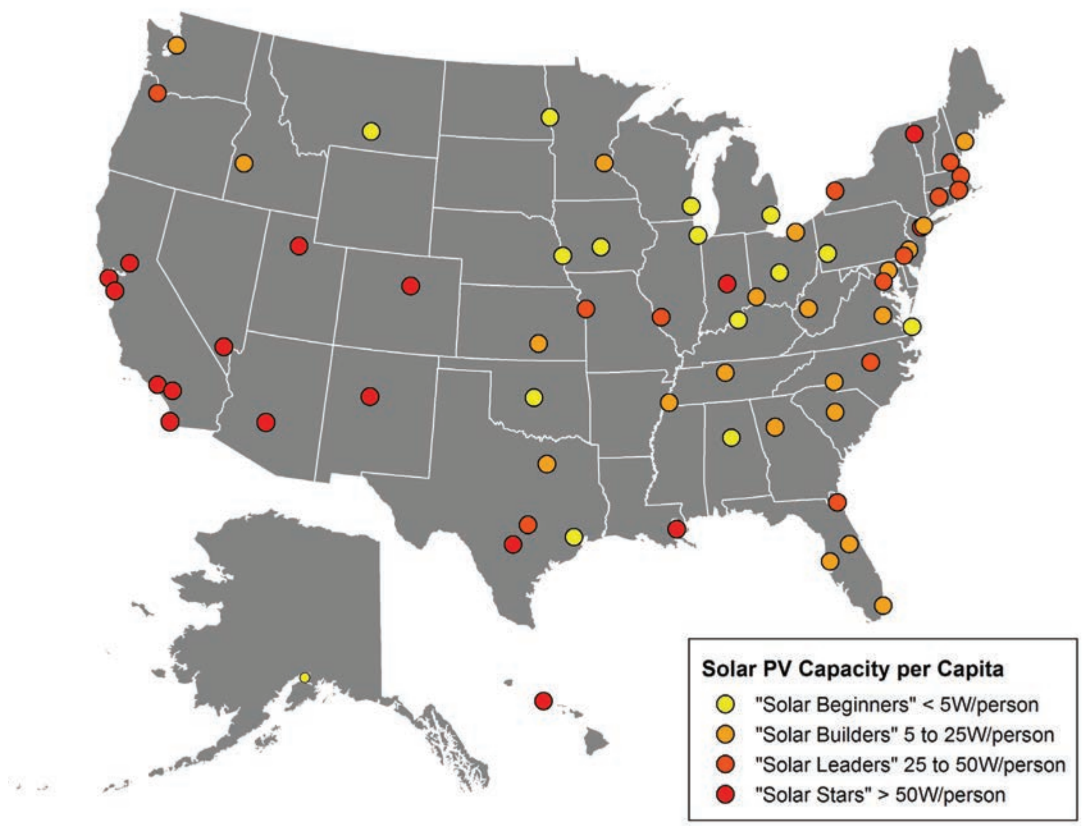

Table ES-2: The "Solar Stars" (Cities with 50 or More Watts of Solar PV per Person, End of 2016)

City	State	Total Solar PV Installed (MW-DC)	Total Solar PV Rank	Per Capita Solar PV Installed (Watts-DC)	Per Capita Rank	Change in Per Capita Rank 2015-2016
Honolulu	HI	175	3	495.2	1	0
San Diego	CA	303	1	217.6	2	+2
San Jose	CA	174	4	169.1	3	0
Indianapolis	IN	127	6	148.5	4	-2
Albuquerque	NM	82	9	146.1	5	0
Las Vegas	NV	75	10	119.6	6	+1
Phoenix	AZ	165	5	105.6	7	-1
Riverside	CA	32	15	98.9	8	+1
New Orleans	LA	37	14	95.0	9	-1
Sacramento	CA	40	13	81.4	10	+2
Burlington	VT	3	45	81.0	11	+2
San Antonio	TX	117	8	79.5	12	-2
Newark	NJ	22	20	78.1	13	-2
Salt Lake City	UT	15	23	77.5	14	0
Los Angeles	CA	267	2	67.1	15	0
Denver	CO	45	12	66.4	16	N/A
San Francisco	CA	46	11	53.5	17	-1

also provides power for the city's wastewater treatment plant.[5] Tampa and Raleigh have also installed large PV systems on city facilities and Albuquerque set a goal in 2016 to power its buildings with 25 percent solar energy by 2025.[6] Cities that invest in solar power on public buildings not only save money on electricity, but they also demonstrate the value of solar energy to their residents.

- **Expanding access through community solar policies and programs:** Baltimore is making solar energy accessible to low-income households, nonprofits and small businesses through new loan and financing programs.[7] Groups of homeowners and businesses in Athens, Georgia, and other cities have organized bulk purchasing programs that drive down the cost for everyone involved.[8] New York and other cities are opening the solar energy market to apartment dwellers and others unable to install solar panels on their own roofs through Power Purchase Agreements (PPAs) that allow residents to purchase shares of solar power from other electric utility accounts.

- **Making it easier and cheaper to switch to solar energy:** In 2016, Kansas City, Missouri, and 21 other cities were recognized by the SolSmart Program for lowering the costs and time involved in switching to solar energy.[9] Kansas City earned the acknowledgment for allowing consumers to complete their solar energy permitting process entirely online and for making its building code more friendly to solar energy installations.[10] Non-hardware costs, like zoning and permitting, now make up about two-thirds of the total price of residential solar systems, so changes like these will significantly lower the barriers for consumers to switch to solar energy.[11]

- **Adopting local policies that make solar energy the default:** In 2016, San Francisco became the first major U.S. city to require that solar energy systems be installed during the construction of new buildings.[12] It is much easier and cheaper to install systems when the structure is designed for their inclusion and when there is already equipment on-site.[13] The state of California is now considering adopting a similar proposal.[14]

Cities with strong policies to compensate consumers for the solar energy they supply to the grid—such as net metering—are often leaders in solar development. Like rollover minutes on a cell phone bill, net metering gives renewable energy customers fair credit on their utility bills for the excess clean power they deliver to the grid. This simple billing arrangement is one of the most important policies for clearing the way for customer investment in solar.

Because net metering is such a powerful incentive for customers to switch to solar energy, fossil fuel interests and utilities have been attacking these policies across the country. In 2016 alone, 28 states proposed or passed changes to their net metering rules.[15] For cities in these states, the changes have the potential to threaten their standing as solar energy leaders. For example, the controversial December 2015 decision by the Nevada Public Utility Commission to weaken net metering may threaten Las Vegas' position as a top solar energy leader in the future.[16]

U.S. cities have only begun to tap their solar energy potential. Cities such as Los Angeles, New York, Chicago and San Antonio have the technical potential to generate tens to hundreds of times more solar energy than they currently do, according to a National Renewable Energy Laboratory (NREL) analysis of technical rooftop solar potential on small buildings.[17] In fact, the majority of the cities in this report have developed less than 2 percent of their technical solar PV potential and the city that has tapped the greatest share of its potential, Newark, developed less than 15 percent of it. By maintaining strong pro-solar public policies, these and other cities can continue to lead America toward a future of 100 percent clean, renewable energy.

Strong public policies at every level of government can help the United States continue to harness clean solar energy. To achieve the nation's full solar potential:

- **Local governments** should follow the lead of top solar cities by setting strong goals for solar energy adoption, implementing programs and policies that promote the rapid expansion of solar energy, expanding access to all residents, installing solar energy systems on government buildings, and urging state and federal officials and investor-owned utilities to facilitate the growth of solar energy.
- **State governments** should set ambitious goals for solar energy adoption and adopt policies to meet them. It is critical that states have strong policies, such as net metering, to fairly compensate owners of solar energy systems for the energy they supply to the grid. States can also enact strong renewable electricity standards with solar carve-outs, community solar legislation, tax credits for solar energy, and public benefits charges on electricity bills to raise funds for solar energy programs, as well as promote solar programs for low-income households. State governments should use their role as the primary regulators of electric utilities to encourage utility investments in solar energy and implement rate structures that maximize the benefits of solar energy to consumers.
- **The federal government** should maintain federal tax credits for solar energy and add provisions to enable nonprofit organizations, housing authorities and others who are not eligible for tax credits to benefit from those incentives. Federal officials should also increase investments for research, development and deployment programs designed to reduce the cost of solar energy and to speed the deployment of renewable energy, energy storage and smart grid technologies. These actions will be critical for the federal government to fulfill the commitments made in the Clean Power Plan and Paris Climate Agreement.

Introduction

Solar power is an American success story. A rarity just a decade ago, the United States saw its one-millionth solar energy installation in February 2016.[18] After a year of record-breaking growth in 2016, U.S. solar PV capacity reached 42 gigawatts (GW), enough to power 8.3 million homes and to reduce carbon dioxide emissions by 52.3 million metric tons annually.[19] Improvements in solar technology and rapidly declining costs are making solar energy more attractive with each passing year.

The rise of solar power over the past decade has been largely driven by cities. In these densely-populated areas, solar power is helping to clean the air and reduce global warming pollution, delivering benefits for the environment and people of all walks of life.

Some cities have demonstrated exceptional leadership in adopting solar power. The key difference between these cities and those that are lagging is effective public policy. Federal tax credits for renewable energy are making an important contribution to fueling growth in solar power, but state and local policies are also core ingredients of a successful solar market. Cities where solar homeowners are paid a fair price for the energy they supply to the grid, where installing solar panels is easy and hassle-free, where there are attractive options for solar financing, and where there has been a strong commitment to support solar energy development, are cities where solar energy is taking off.

American solar energy is at a tipping point. We are nearing the threshold where solar power is cheaper than electricity generated by fossil fuels and the conditions are in place for mass adoption of solar energy. In fact, a report published by GTM Research in February 2016 found that 20 U.S. states had realized "grid parity" and predicted that 42 would by 2020. Grid parity is the point at which a solar customer's first year electric bill savings are greater than the first year's share of the overall cost of the solar system.[20]

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

The rapid spread of low-cost solar power has posed a threat to the business models of fossil fuel interests and some utilities, which have united in an effort to slow the progress of solar energy. In 2016 alone, 28 states proposed or passed changes to their net metering rules.[21] The outcome of those battles will determine how rapidly our cities and the rest of the nation can reap the benefits of the solar revolution.

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

Solar Power Is Good for Cities

Solar energy helps cities fight global warming, reduce air pollution and strengthen electric grids, and offers consumers security against volatile energy costs.

Solar Energy Reduces Harmful Global Warming Pollution

America can limit the future impact of global warming by slashing our use of the dirty energy sources that cause it.[22] Unlike electricity produced from fossil fuels, solar power generation produces no global warming pollution. Even when emissions from manufacturing, transportation and installation of solar panels are included, solar power generation produces 96 percent less global warming pollution than coal-fired power plants over its entire life-cycle, and 91 percent less global warming pollution than natural gas-fired power plants.[23] By replacing fossil fuels with solar-powered electricity, we can dramatically cut carbon pollution and reduce 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 linked to stroke, heart disease, acute respiratory disease, asthma and lung cancer.[24] These conditions can lead to disability, prolonged absences from work or school, and even death.[25] One study found that pollution from electric power plants is responsible for about 50,000 U.S. deaths per year.[26] Cities in the Midwest and Mid-Atlantic, such as Baltimore, Cleveland, St. Louis and Washington, D.C., bear a particularly heavy health burden from power plant pollution.[27]

Solar energy reduces the need for polluting, fossil fuel-generated electricity. Given the high social and economic costs of air pollution-related illnesses, solar energy is a smart investment in human health and our economy.

Solar Energy Makes Cities More Resilient to Severe Weather

Solar energy helps cities conserve water in times of drought. Nationally, electricity production accounts for about 40 percent of freshwater withdrawals.[28] 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.[29] In fact, the life-cycle water consumption of solar PV is 1/500th of the life-cycle water consumption of coal power plants and 1/80th that of natural gas plants per unit of electricity produced.[30]

During periods of hot weather, solar power, which is most available when it is sunny, helps meet demand for electric power for air conditioning. The close alignment of power supply and power demand at these times helps cities avoid the need to turn on "peaker" power plants—plants that are too expensive to run regularly.[31] Because the impact of air pollution is most harmful when temperatures are high, relying on solar power during hot weather also helps improve public health.[32]

Solar energy can even help to protect cities in the face of severe storms. If transmission lines are disrupted, solar microgrids can help prevent blackouts by going temporarily "off the grid" and providing power directly to the facilities where they are generating electricity.[33]

Solar Energy Benefits Consumers

Cities that make solar energy accessible and affordable provide direct and indirect economic benefits to their residents. These benefits are enjoyed by both solar energy customers and other members of the community.

Homeowners and businesses who install solar panels on their buildings, known as distributed solar PV systems, can generate their own electricity. Because energy from the sun is free once the system is installed, these solar consumers are also protected from the volatile prices of fossil fuel markets.

In addition, many states allow customers whose solar PV systems produce more electricity than they need to receive a credit at the retail rate for power sent back to the electric grid, a practice known as net metering. Net metering functions similarly to rollover minutes on a cell phone plan, adding credits to a solar customer's future electric bill. On average, about 20 to 40 percent of a solar energy system's output is exported back to the electric grid, serving nearby customers.[34] The credits collected by system owners can help them recoup initial investments made in PV systems over time.

Distributed Solar Electricity Provides Benefits to the Broader Electric Grid

The benefits of solar energy extend beyond the buildings on which PV panels are installed. Distributed solar energy provides additional electric generating capacity during periods of peak demand, reducing a utility's need to generate or purchase power from the expensive, often inefficient "peaker" power plants.[35] Generating more electricity closer to the locations where it is used also reduces the need to construct or upgrade expensive transmission capacity. Localized electricity generation minimizes the amount of energy lost during transmission, improving electric system efficiency.[36]

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

City leaders and residents are taking advantage of the significant opportunities offered by solar energy as the U.S. solar energy boom continues to accelerate.

In leading cities, officials are setting ambitious goals for solar energy adoption, are putting solar panels on city buildings, and are working with utilities to upgrade the electric grid and offer electricity customers incentives to invest in solar energy systems. In these cities, permitting departments are taking steps to reduce fees and processing time for solar installation applications. And, city residents, individually and with their neighbors, are cutting their electricity bills and contributing to a cleaner environment by putting solar panels on their homes and apartment buildings.

This report is our fourth review of solar photovoltaic installations in U.S. cities. This year, the list of cities to be surveyed started with the primary cities in the top 50 most populous Metropolitan Statistical Areas in the United States according to the U.S. Census Bureau.[37] If a state did not have a city included in that list, its largest city was added to the list to be surveyed. For a complete list of cities, see Appendix B. If reliable data was ultimately unavailable for a city, it was dropped from the list.[38]

Solar panels on a home in Denver, CO.

There is no uniform, comprehensive national data source that tracks solar energy by municipality, so the data for this report come from a wide variety of sources. (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.

The Top 20 Solar Cities Have 2 Gigawatts of Solar Energy Capacity

Cities that lead the nation in installed solar PV capacity come from all regions of the United States.

As of the end of 2016, the United States has installed just over 42 GW of solar PV capacity.[39] The top 20 cities in our report hosted nearly 2 GW of that capacity. **Despite making up only 0.1 percent of the nation's land area, these cities contain almost 5 percent of U.S. solar PV capacity.**[40]

In 2016, San Diego bumped out Los Angeles, the leader in all three previous reports, to become the nation's leader in total installed solar PV capacity. Honolulu rose from sixth place in our 2015 report to secure the third place position this year. San Jose and Phoenix, this year's fourth and fifth place cities respectively, have been amongst the top five cities in all four editions of this report. (See Table 1 and Figure 1.)

Figure 1: U.S. Cities by Cumulative Installed Solar PV Capacity, End of 2016

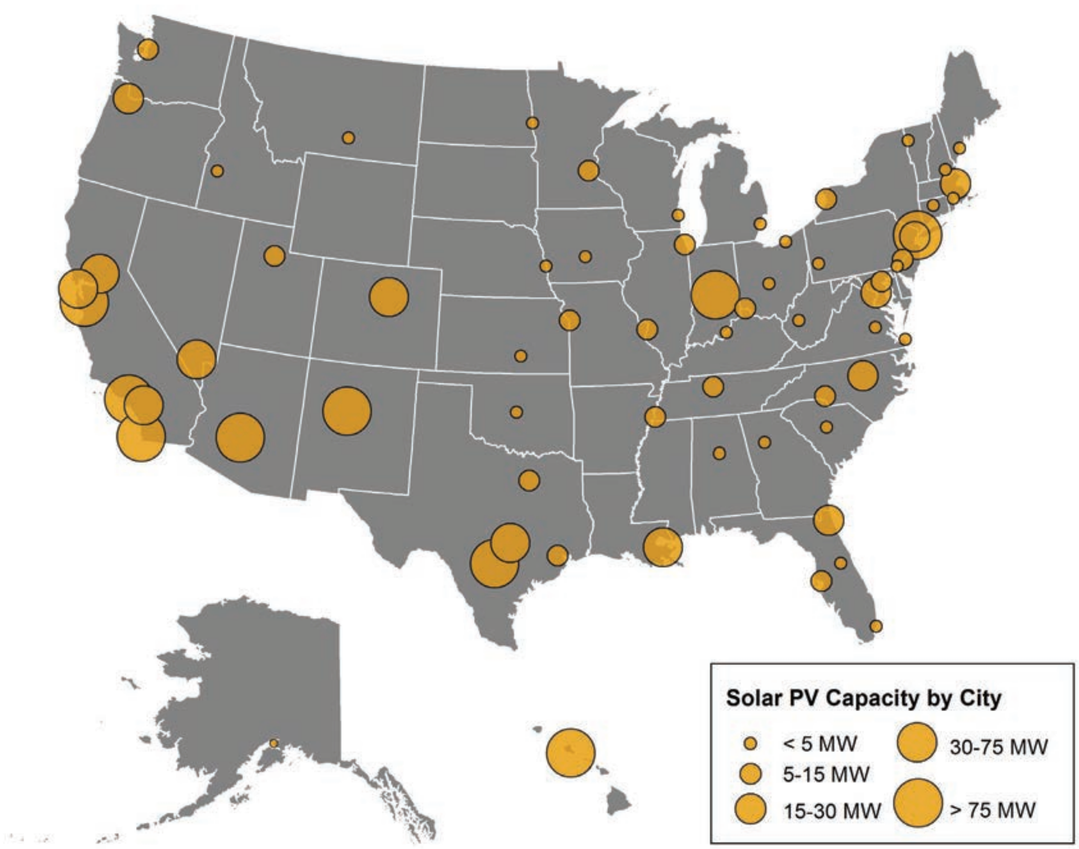

Table 1: Top 20 Solar Cities by Total Installed Solar PV Capacity, End of 2016[41]

City	State	Total Solar PV Installed (MW-DC)	Total Solar PV Rank	Per Capita Solar PV Installed (Watts-DC)	Per Capita Rank	Rooftop Solar PV Potential (MW) †
San Diego	CA	303	1	217.6	2	2,219
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San Jose	CA	174	4	169.1	3	1,639
Phoenix	AZ	165	5	105.6	7	2,981
Indianapolis	IN	127	6	148.5	4	N/A
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San Antonio	TX	117	8	79.5	12	3,721
Albuquerque	NM	82	9	146.1	5	1,252
Las Vegas	NV	75	10	119.6	6	946
San Francisco	CA	46	11	53.5	17	672
Denver	CO	45	12	66.4	16	677
Sacramento	CA	40	13	81.4	10	777
New Orleans	LA	37	14	95.0	9	1,277
Riverside	CA	32	15	98.9	8	612
Austin*	TX	31	16	33.0	24	1,443
Portland	OR	27	17	43.0	19	1,397
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Jacksonville	FL	25	19	29.0	27	1,715
Newark	NJ	22	20	78.1	13	154

† This 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.[42]

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

Cities Ranked by Per Capita Solar PV Capacity

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, can provide an idea of how densely developed solar energy is in a city.

"Solar Stars" are cities with 50 or more watts of installed solar PV capacity per person. These are cities that have experienced dramatic growth in solar energy in recent years and are setting the pace nationally for solar energy development. Honolulu, San Diego, San Jose, Indianapolis, and Albuquerque are the top five cities in the nation for installed solar PV capacity per person.

Figure 2: U.S. Cities by Per Capita Installed Solar PV Capacity, End of 2016 (Watts Per Person)

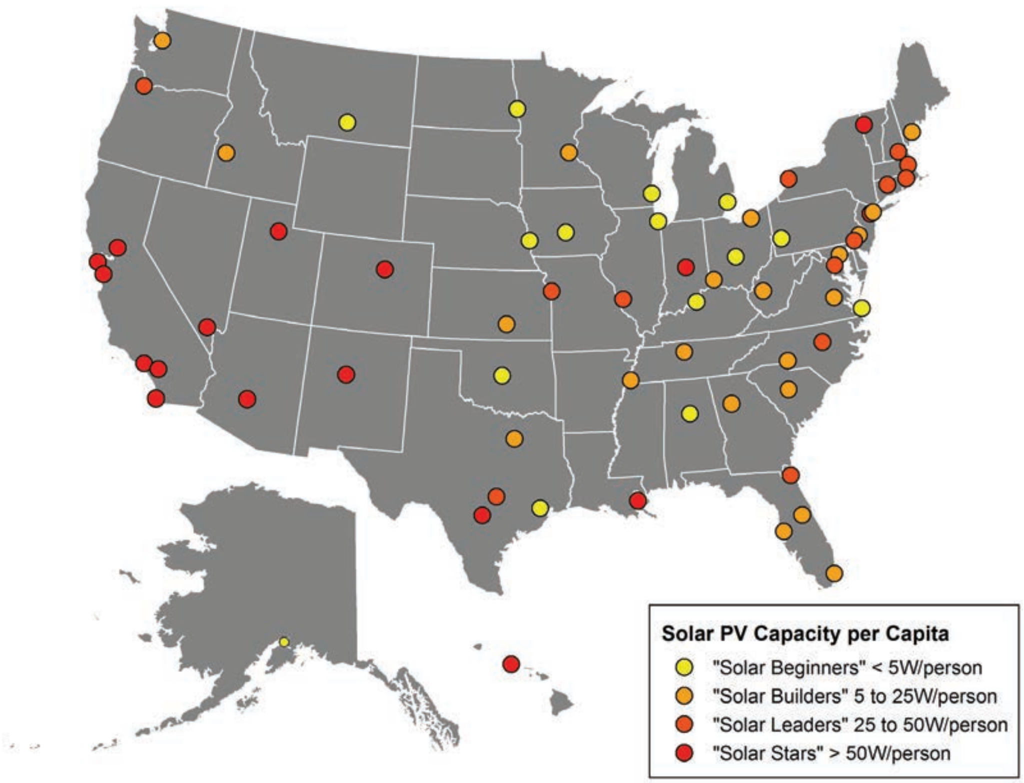


Table 2: The "Solar Stars" (Cities with 50 or More Watts of Solar PV per Person, End of 2016)

City	State	Total Solar PV Installed (MW-DC)	Total Solar PV Rank	Per Capita Solar PV Installed (Watts-DC)	Per Capita Rank	Change in Per Capita Rank 2015-2016
Honolulu	HI	175	3	495.2	1	0
San Diego	CA	303	1	217.6	2	+2
San Jose	CA	174	4	169.1	3	0
Indianapolis	IN	127	6	148.5	4	-2
Albuquerque	NM	82	9	146.1	5	0
Las Vegas	NV	75	10	119.6	6	+1
Phoenix	AZ	165	5	105.6	7	-1
Riverside	CA	32	15	98.9	8	+1
New Orleans	LA	37	14	95.0	9	-1
Sacramento	CA	40	13	81.4	10	+2
Burlington	VT	3	45	81.0	11	+2
San Antonio	TX	117	8	79.5	12	-2
Newark	NJ	22	20	78.1	13	-2
Salt Lake City	UT	15	23	77.5	14	0
Los Angeles	CA	267	2	67.1	15	0
Denver	CO	45	12	66.4	16	N/A
San Francisco	CA	46	11	53.5	17	-1

"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 "Solar Star" rank.

Table 3: The "Solar Leaders" (Cities with 25 - 50 Watts of Solar PV Per Person, End of 2016)

City	State	Total Solar PV Installed (MW-DC)	Total Solar PV Rank	Per Capita Solar PV Installed (Watts-DC)	Per Capita Rank	Change in Per Capita Rank 2015-2016
Wilmington	DE	3	44	47.9	18	-1
Portland	OR	27	17	43.0	19	+1
Raleigh	NC	19	22	42.7	20	+5
Washington, D.C.	DC	25	18	37.5	21	+8
St. Louis	MO	11	30	33.4	22	-3
Hartford	CT	4	42	33.0	23	+4
Austin*	TX	31	16	33.0	24	N/A
Boston	MA	20	21	29.5	25	-1
Kansas City	MO	14	25	29.5	26	-4
Jacksonville	FL	25	19	29.0	27	-6
Buffalo	NY	7	34	28.2	28	+6
Providence	RI	5	39	26.5	29	-6
Manchester	NH	3	49	26.2	30	+1

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

The Solar Builders are those with between 5 and 25 watts of installed solar PV capacity per person. This diverse group of cities includes cities that have a history of solar energy leadership as well as cities that have only recently experienced significant solar energy development.

Table 4: The "Solar Builders" (Cities with 5 - 25 Watts of Solar PV Per Person, End of 2016)

City	State	Total Solar PV Installed (MW-DC)	Total Solar PV Rank	Per Capita Solar PV Installed (Watts-DC)	Per Capita Rank	Change in Per Capita Rank 2015-2016
Tampa	FL	9	32	24.4	31	-5
Seattle	WA	15	24	21.2	32	0
Cincinnati	OH	6	36	19.1	33	-3
Baltimore*	MD	11	29	18.2	34	N/A
Portland	ME	1	58	16.9	35	+7
Richmond	VA	3	47	13.8	36	-3
Charlotte	NC	11	28	13.7	37	+6
New York	NY	117	7	13.7	38	0
Columbia	SC	2	53	13.4	39	+15
Minneapolis	MN	5	38	12.9	40	-4
Orlando	FL	3	48	11.0	41	-6
Boise City	ID	2	51	10.0	42	+2
Miami	FL	4	41	9.6	43	+18
Dallas	TX	12	27	9.5	44	+3
Atlanta	GA	4	40	9.2	45	-5
Nashville	TN	6	35	8.8	46	-5
Cleveland	OH	3	46	8.7	47	-8
Memphis	TN	5	37	8.2	48	-3
Philadelphia	PA	10	31	6.2	49	-3
Wichita	KS	2	52	5.5	50	N/A
Charleston	WV	< 1	65	5.4	51	-2

**Due to an improvement in methodology or data source for this city, total and per capita solar PV capacities reported in this table are not directly comparable with estimates for this city in previous versions 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 5: The "Solar Beginners" (Cities with Less than 5 Watts of Solar PV Per Person, End of 2016)

City	State	Total Solar PV Installed (MW-DC)	Total Solar PV Rank	Per Capita Solar PV Installed (Watts-DC)	Per Capita Rank	Change in Per Capita Rank 2015-2016
Pittsburgh	PA	1	55	4.8	52	-1
Chicago	IL	13	26	4.6	53	-5
Milwaukee	WI	3	50	4.5	54	-2
Columbus	OH	4	43	4.1	55	-5
Billings*	MT	< 1	63	3.5	56	N/A
Houston	TX	8	33	3.4	57	-4
Des Moines	IA	1	61	2.9	58	-3
Oklahoma City	OK	2	54	2.6	59	-3
Detroit	MI	1	56	2.1	60	0
Louisville	KY	1	57	2.0	61	-3
Omaha	NE	1	59	1.8	62	-5
Anchorage	AK	1	62	1.8	63	-1
Virginia Beach	VA	1	60	1.4	64	-5
Birmingham	AL	< 1	64	1.3	65	-2
Fargo	ND	< 1	66	1.0	66	-2

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

Cities Ranked by Region

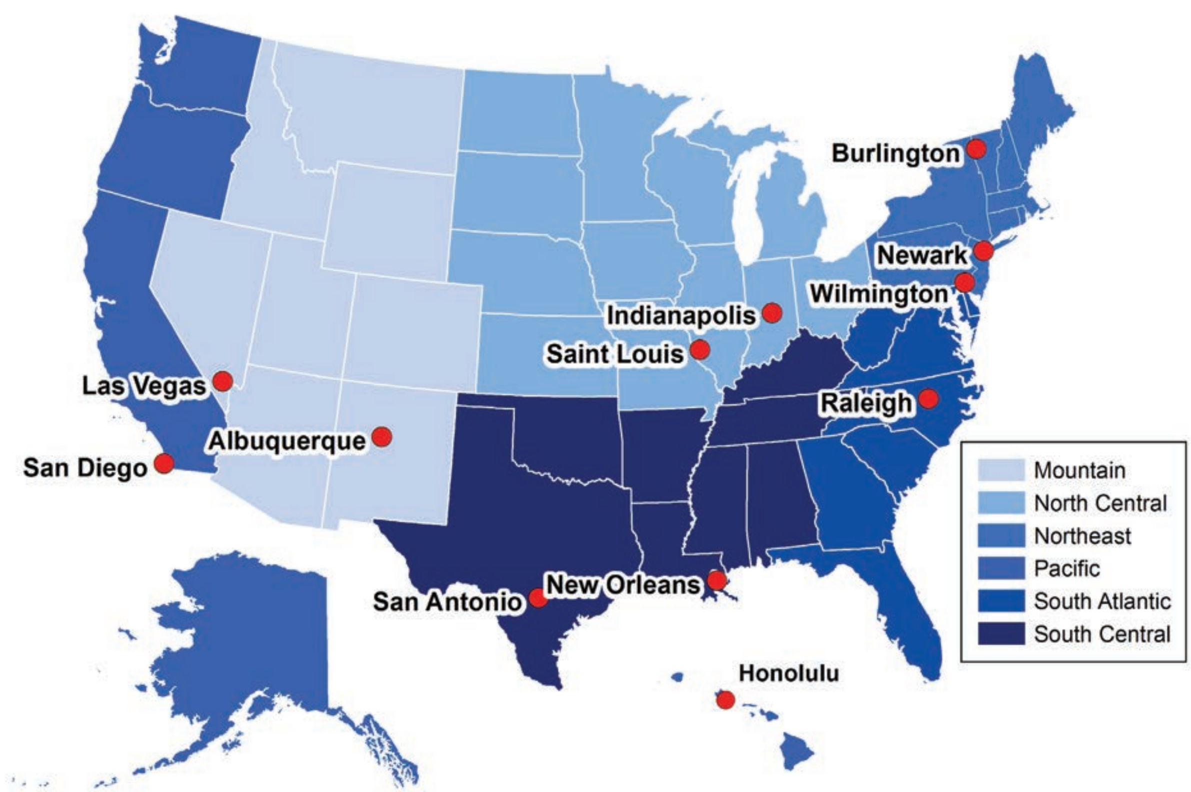
We also ranked the cities by region to highlight the leaders from different parts of the United States. Table 6 lists the top two cities in each region with the most installed solar PV capacity per city resident. For this analysis, we used regional designations from the U.S. Census, grouping some regions together for more logical comparisons. 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 495 watts of solar PV capacity installed per person. Other regional leaders include Indianapolis for the North Central region (149 watts/person), Albuquerque for the Mountain region (146 watts/person), New Orleans for the South Central region (95 watts/person), Burlington for the Northeast region (81 watts/person) and Wilmington, Delaware, for the South Atlantic region (48 watts/person).

Table 6: Top Two Cities in Each Region Ranked by Solar PV Capacity Installed Per Person, End of 2016

City	State	Region	Total Solar PV Installed (MW-DC)	Regional Total PV Rank	Per Capita Solar PV Installed (Watts-DC)	Regional Per Capita Rank
Albuquerque	NM	Mountain	82	2	146.1	1
Las Vegas	NV	Mountain	75	3	119.6	2
Indianapolis	IN	North Central	127	1	148.5	1
St. Louis	MO	North Central	11	4	33.4	2
Burlington	VT	Northeast	3	8	81.0	1
Newark	NJ	Northeast	22	2	78.1	2
Honolulu	HI	Pacific	175	3	495.2	1
San Diego	CA	Pacific	303	1	217.6	2
Wilmington	DE	South Atlantic	3	9	47.9	1
Raleigh	NC	South Atlantic	19	3	42.7	2
New Orleans	LA	South Central	37	2	95.0	1
San Antonio	TX	South Central	117	1	79.5	2

Figure 3: Top Two Cities in Each Region Ranked by Solar PV Capacity Installed per Person, End of 2016



The Promise of Solar Power for U.S. Cities Is Enormous

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 potential. A National Renewable Energy Laboratory (NREL) study estimated that rooftop solar power alone is technically capable of contributing 1,118 GW of generating capacity to the national electric grid.[43] That is enough solar energy to cover the annual electricity needs of more than 135 million homes.[44] Cities also have the potential to develop solar energy on larger buildings and in utility-scale installations on open land – adding to the clean energy they can provide to the grid.

Even the nation's leading solar cities have immense untapped solar energy potential. The top ranked city currently, San Diego, has developed less than 14 percent of its technical potential for solar power on small buildings. The NREL study found that Los Angeles, the second highest ranked city, with 267 MW installed, could host up to 9,000 MW of solar PV capacity on its rooftops. This would be enough capacity to provide up to 60 percent of the electricity the city currently uses. Newark has developed more of its potential than any other city on this list and that is still less than 15 percent. Most cities on this list have developed less than 2 percent of their technical potential for rooftop solar power. San Antonio and Chicago could each accommodate more than 6,000 MW of solar PV capacity on city rooftops and Baltimore, New York, Charlotte, Detroit, Milwaukee, New Orleans, Philadelphia and Portland, OR could all install at least 2,000 MW of solar PV capacity on their rooftops.[45]

Cities with Ambitious Solar Energy Goals and Pro-Solar Policies Are Creating a Clean Electric Grid

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

The leading cities have followed a variety of paths in developing solar energy. In some cases, city 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 cities with municipal utilities have had an even more direct influence on solar power adoption by establishing ambitious requirements for solar energy and implementing effective financial incentives. Some cities have taken steps to increase the use of solar energy on public facilities, while, in other cities, strong state policies are driving local solar power growth. As demonstrated in the following case studies, cities can most effectively promote solar power when city, state and utility policies work together.

Kansas City is Making It Easier, Cheaper and Faster to Switch to Solar Energy

Kansas City is making transitioning to solar energy more appealing to customers by reducing the red tape involved. In 2016, the SolSmart program recognized Kansas City and 21 other communities around the nation for reducing the time and non-equipment costs of installing solar energy systems.[46] The SolSmart program, which is funded by the U.S. Department of Energy SunShot Initiative, helps local governments reduce barriers to solar energy growth at no cost.[47] Kansas City received their top recognition for adding provisions to its Zoning and Development Code that allow solar energy systems to be installed as accessory uses on any property in the city. The city also simplified its permitting process, allowing all plans to be submitted, reviewed and approved entirely online.[48] Non-hardware costs, like planning, zoning, financing and permitting now make up about two-thirds of the total price of residential solar systems, so these changes will offer customers huge savings.

Smart Local Policies Are Driving Solar Energy Adoption in San Francisco

San Francisco is already a solar energy leader, in the top 20 for both total and per capita installed solar PV capacity at the end of 2016, and the city has ambitious plans for the future. In 2010, San Francisco began an initiative to transition to 100% renewable energy by 2020 and is taking big steps toward that goal through forward-thinking local policies.[49] Last May, San Francisco became the first major city in the nation to require that photovoltaic or solar thermal solar systems be installed during the construction of new homes and businesses.[50] This ordinance, which went into effect on January 1, 2017, follows the example set by Lancaster and Sebastopol, smaller cities in California that passed similar ordinances in 2013.[51] The ordinance is enforced through the Planning Code and offers exemptions for projects that would be infeasible at the discretion of the director of the Department of Building Inspection.[52]

These ordinances model a great opportunity for cities in states with weak solar policies to drive the transition to renewable energy themselves. These policies are also a particularly smart and cost-effective way to do so. As San Francisco's new legislation explains, "requiring solar [energy] at the time of new construction is more cost-effective than installing the equipment after construction because workers are already on-site, permitting and administrative costs are lower, and it is more cost effective to include such systems in existing construction financing." [53] And because many U.S. cities are seeing construction booms, there's never been a better time to ensure that new development brings clean, renewable energy along with it. In January 2017, a bill was introduced in the California State Senate that would replicate this policy statewide.[54]

Local Groups Tripled Residential Solar in Athens in 2016 through Bulk Purchasing Program

In less than five months, the bulk purchasing program "Solarize Athens" more than tripled the residential solar energy capacity in the Athens, Georgia metropolitan area. Solarize Athens was led by the groups Environment Georgia, the Georgia Climate Change Coalition, Georgia Interfaith Power and Light, and Solar Crowd Source. Bulk purchasing programs

Photo: Solarize Athens

Solar panels on a home in Athens, GA.

like this allow businesses, homeowners and nonprofits to purchase solar energy collectively, thus lowering the cost for everyone involved.[55] Solarize Athens exceeded the critical mass of participants needed for everyone to pay the lowest price offered. This represented a 10 percent reduction in costs for participants, from the start price of $3.19/watt to $2.90/watt. When the program ended on April 30, 2016, 76 contracts had been signed to install a total of 414.55 kW of solar energy capacity in the Athens-Clarke County area. These installations will offset 811,027 million pounds of carbon dioxide, equivalent to taking over 77 million cars off the road.[56]

Baltimore Expands Solar Energy Access to Low-Income Households, Nonprofits and Small Businesses

In July 2016, Baltimore signed an agreement with the U.S. Department of Energy and the Maryland Clean Energy Center to develop a financing model that will make solar energy more accessible to low-income customers. [57] Solar energy systems provide low-income households with security against volatile energy costs, lower energy bills and monthly credit for the extra energy they send back to the utility. However, the bulk of the cost of switching to solar energy comes upfront, making it unavailable to households that don't qualify for loans or that have insufficient savings. The new Baltimore program will help people surmount that barrier. Baltimore also has a loan program for nonprofits and small businesses to finance solar energy systems.[58] These programs, coupled with Maryland's strong net metering policy, are helping increase solar energy in Baltimore quite rapidly. Baltimore's solar PV capacity increased 62 percent in just one year, from 7 MW at the end of 2015 to 11 MW at the end of 2016.

The City of Albuquerque Is Leading by Example through Ambitious Solar Energy Goals

On September 20, 2016, the Albuquerque City Council unanimously passed a resolution to receive 25 percent of electricity used by city facilities from solar energy by 2025. The City of Albuquerque currently gets about 3 percent of its electricity from solar energy and this large increase will lead to significant savings for the city, approximately $3.6 million each year at current electric rates. [59] This will offer the city significant budget security against fluctuating energy costs and will likely lead to even greater savings in the future.

Photo: Energy.gov

Solar panels at the Pueblo Cultural Center in Albuquerque, NM.

Policy Recommendations

U.S. cities, as centers of population growth and energy consumption, must lead the way in building a grid powered by clean, renewable energy. Many cities have already experienced the havoc that global warming can cause through severe weather, drought, increased precipitation and intense heat waves. Increasing solar energy capacity, encouraging innovation, and expanding access to PV systems will be critical tools for creating a clean electricity system and addressing global warming.

Research shows that solar energy policies—more than the availability of sunshine—dictate which states have successful solar industries and which do not.[60] 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 solar energy development with large projects. Policy-makers at every level of government—federal, state and local—have an important role to play in making solar energy in American cities a reality.

Local governments should:

- ***Set ambitious solar energy goals*** – The cities that are leading in solar energy adoption are not doing so by chance. The current leader for total installed solar PV capacity, San Diego, has set the ambitious goal of generating 100% of its energy from renewable sources by 2035.[61] A large part of the city's plan to achieve this goal is implementing programs that promote solar energy.[62]
- ***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 neighbors or homeowners' associations. Local governments should also offer clear zoning regulations that allow solar energy installations on residential and commercial rooftops, which will help unlock new solar markets in communities.[63] The Delaware Valley Regional Planning Commission offers a model ordinance guide that cities can apply to their own local laws.[64]
- ***Adopt policies to promote "solar ready" or zero-net energy homes*** – 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. The city of San Francisco now requires that all new buildings be constructed with solar systems installed.[65] The city of Tucson requires that any 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.[66] Other jurisdictions set goals for new zero-net energy homes that employ energy efficiency and renewable energy technologies such that they produce as much energy as they consume.

- ***Eliminate red tape by reforming permitting processes*** – Reducing fees, making permitting rules clear and readily available, speeding up the permitting process, and making inspections convenient for property owners can help residents "go solar."[67] The Department of Energy's SunShot Initiative helps cities to fund programs that work toward this goal, such as Kansas City's work to make its solar energy permitting process available online and to update its building code to be more friendly to solar energy.[68] Vote Solar (formerly known as The Vote Solar Initiative) has also laid out a series of best practices that local governments can follow to ensure that their permitting process is solar-friendly.[69] Cities should also adopt best practices related to energy storage systems, which are often associated with solar systems. City governments should strive to lower the soft costs associated with these systems and make sure there aren't any barriers in local zoning ordinances to installing them.

- ***Expand access to solar energy*** – Statewide and citywide financing programs, like those implemented in Baltimore, can make solar energy available to low-income households, nonprofits and small businesses. "Solarize" bulk purchasing programs like "Solarize Athens," along with community solar programs, have also been successful at lowering the cost of solar energy systems for communities.[70] Practices like PPAs utilized in New York and elsewhere can allow apartment occupants and others who cannot install their own solar systems to benefit from solar energy, too.

- ***Consider municipalization where 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 wish to consider forming a municipal utility in order to gain greater control over their local electric grids. The City of Minneapolis, for example, recently partnered with the two investor-owned utilities serving the city in order to meet their goal of reducing emissions by 30% by 2025. However, the partnership came only after there was a push for municipalization in Minneapolis that drove the utilities to consider a more aggressive approach to renewable energy.[71]

- ***Support 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 push their state governments to enact the policies recommended below.

- ***Install solar panels on public buildings*** – Local governments can promote solar energy by installing solar panels and signing solar PPAs for public buildings. According to a report from The Solar Foundation for the U.S. Department of Energy, at least 3,752 schools across the country had installed solar energy systems with a combined capacity of 490 MW by 2014.[72] In 2016, the City 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. Not only do these installations save governments money on their electricity bills, they also serve as a public example of a smart, clean energy investment.

State governments should:

- ***Ensure that utilities invest in solar energy*** – States should adopt or increase mandatory renewable electricity standards with solar carve-outs that require a significant and growing share of that state's electricity to come from the sun. States should also 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 bill that will require utilities to generate 100% of the energy they sell from renewable resources by 2045.[73]

- ***Adopt and preserve strong statewide interconnection and net metering policies*** – These critical policies ensure that individuals and businesses are appropriately compensated for the electricity that they export to the grid, and allow them to move seamlessly between producing their own electricity and using electricity from 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 a fair price 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.

- ***Establish policies that expand solar energy access to all Americans*** – According to NREL, 49 percent of Americans don't own a home, have shading on their homes, or cannot afford a solar system. Policies such as virtual or aggregate net metering and shared solar allow low-income households, renters and apartment dwellers to access the benefits of solar energy.[74]

- ***Establish public benefits charges on utility bills or other sustainable financing mechanisms –*** 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.

- ***Ensure that electric rate designs encourage solar adoption*** – Many utilities are now proposing rate designs that add charges to electric bills in a way that would harm solar adoption. These charges include higher fixed charges and "demand charges," which typically apply to the 15-minute period during the month when a customer uses the most energy.[75] Structures like this limit the benefits of adopting solar, as they cause solar customers to pay almost as much on their energy bills as traditional customers, even though they use far less energy from the utility over the course of the month.[76] State governments should reject unfair proposals like this that discourage customers from switching to solar energy.

- ***Implement policies that support energy storage, electric vehicle smart charging and microgrids*** – State governments must design policies that facilitate the transition from a power grid reliant on large, centralized power plants to a "smart" grid where electricity is produced at thousands of locations and shared across an increasingly nimble and sophisticated infrastructure. Such state policies should support the expansion of energy storage technologies, electric vehicle smart charging networks and microgrids.

- ***Use solar energy to meet and exceed targets set by the Clean Power Plan*** – States should include the expansion of solar-powered electricity generation in their strategies to reduce power plant emissions under the federal Clean Power Plan.

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.[77] The federal government should maintain federal tax credits for solar energy, but add provisions as necessary to enable nonprofit organizations, housing authorities and others who are not eligible for tax credits to benefit from those incentives.

- ***Support research to drive solar power innovations*** – The U.S. Department of Energy's SunShot Initiative has served as a rallying point for federal efforts to encourage the expansion of solar energy.[78] The SunShot Initiative and other efforts facilitate solar energy adoption by investigating the best ways to integrate solar energy into the grid, to deliver solar energy more efficiently and cost-effectively, and to 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 and to strengthen cities' electric grids in the face of extreme weather.

- ***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 U.S. military has committed to getting one-quarter of its energy from renewable sources by 2025 and had already installed more than 130 megawatts of solar energy capacity by 2013.[79]

- ***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 schools and subsidized housing by installing solar power units 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 (LIHEAP), should be expanded to include solar energy.

- ***Defend and strengthen the requirements of the Clean Power Plan*** – The federal government should protect a strong Clean Power Plan to reduce global warming emissions by at least 30 percent below 2005 levels by 2030. Renewable energy sources such as solar PV can play a dominant role in helping the United States achieve these pollution reductions.

- ***Uphold commitments made in the Paris Climate Agreement*** – On September 3, 2016, the United States became one of 129 parties to ratify the Paris Climate Agreement, the first comprehensive, global agreement to address global warming.[80] The agreement aims to keep global temperature rise this century below 2°C above pre-industrial temperatures.[81] This agreement also seeks to strengthen nations' ability to adapt to climate change.[82] As the second largest emitter of greenhouse gases, the U.S. must fulfill its commitment to the Paris Climate Agreement in order for this international goal to be achieved.[83] Implementing the pro-solar energy policies discussed in this report will be key to fulfilling this aim.

Methodology

There is no uniform national data source that tracks solar energy by municipality and there are only a handful of states that compile this information in a comparable format. As a result, the data for this report come from a wide variety of sources – municipal and investor-owned utilities, city and state government agencies, operators of regional electric grids 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 photovoltaic capacity (e.g., alternating current (AC) versus direct current (DC) capacity).

We have worked to obtain data that are as comprehensive as possible, to resolve discrepancies in various methods of estimating solar PV capacity, to limit the solar facilities included to only those within the city limits of the municipalities studied, and, where precise geographic information could not be obtained, to use reasonable methods to estimate the proportion of a given area's solar energy capacity that exists within a particular city. The data are sufficiently accurate to provide an overall picture of a city's adoption of solar power and to enable comparisons with its peers. Readers should note, however, that 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*. This is because we were able to obtain more specific and reliable data this year. In a couple of cases, our current estimate is smaller than previous estimates for the same city, due either to inconsistencies in the data reported to us by cities or improved precision in methods for assigning solar installations to cities. For an explanation of individual discrepancies, see Appendix B.

Selecting the Cities

The cities in this report consist of the 50 most populous cities in the United States and the largest cities in each state not represented on that list.[84] For a complete list of cities, see Appendix A. If we were unable to find reliable data for a city, it was excluded. Cities for which we were unable to find reliable data are: Cheyenne, Wyoming; Jackson, Mississippi and 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.[85]

Converting from AC watts to DC watts

Jurisdictions and agencies often use different methods of quantifying solar photovoltaic capacity (e.g. alternating current (AC) and direct current (DC)). Solar PV panels produce energy in DC, which is then converted to AC in order to 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.[86]

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 numbers from AC to DC megawatts (MW), we used the default derate factor in NREL's *PV Watts* tool of 0.769.[87]

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

In some cases, we were unable to obtain specific data on solar PV capacity, but we were 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 ArcGIS or QGIS software and U.S. Census Bureau cartographic boundary files for Zip Code Tabulation Areas 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 percentage 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	Total Solar PV Installed (MW-DC	Total Solar PV Rank	Population	Per Capita Solar PV Installed (Watts-DC)	Per Capita Rank	Percentage of Small Building Solar PV Potential Installed†
Albuquerque	NM	82	9	559,121	146.1	5	6.5
Anchorage	AK	1	62	298,695	1.8	63	N/A
Atlanta	GA	4	40	463,878	9.2	45	0.9
Austin	TX	31	16	931,830	33.0	24	2.1
Baltimore	MD	11	29	621,849	18.2	34	2.5
Billings	MT	<1	63	110,263	3.5	56	0.2
Birmingham	AL	<1	64	212,461	1.3	65	0.1
Boise City	ID	2	51	218,281	10.0	42	0.5
Boston	MA	20	21	667,137	29.5	25	5.8
Buffalo	NY	7	34	258,071	28.2	28	1.4
Burlington	VT	3	45	42,452	81.0	11	7.9
Charleston	WV	<1	65	49,736	5.4	51	0.2
Charlotte	NC	11	28	827,097	13.7	37	0.8
Chicago	IL	13	26	2,720,546	4.6	53	0.5
Cincinnati	OH	6	36	298,550	19.1	33	1.1
Cleveland	OH	3	46	388,072	8.7	47	0.5
Columbia	SC	2	53	133,803	13.4	39	0.7
Columbus	OH	4	43	850,106	4.1	55	0.2
Dallas	TX	12	27	1,300,092	9.5	44	0.6
Denver	CO	45	12	682,545	66.4	16	6.7
Des Moines	IA	1	61	210,330	2.9	58	0.2
Detroit	MI	1	56	677,116	2.1	60	0.1
Fargo	ND	<1	66	118,523	1.0	66	0.1
Hartford	CT	4	42	124,006	33.0	23	3.5
Honolulu	HI	175	3	352,769	495.2	1	N/A
Houston	TX	8	33	2,296,224	3.4	57	0.2
Indianapolis	IN	127	6	853,173	148.5	4	N/A
Jacksonville	FL	25	19	868,031	29.0	27	1.5
Kansas City	MO	14	25	475,378	29.5	26	1.4
Las Vegas	NV	75	10	623,747	119.6	6	7.9
Los Angeles	CA	267	2	3,971,883	67.1	15	4.9

Continued on page 30

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City	State	Total Solar PV Installed (MW-DC	Total Solar PV Rank	Population	Per Capita Solar PV Installed (Watts-DC)	Per Capita Rank	Percentage of Small Building Solar PV Potential Installed†
Louisville	KY	1	57	615,366	2.0	61	N/A
Manchester	NH	3	49	110,229	26.2	30	1.8
Memphis	TN	5	37	655,770	8.2	48	0.4
Miami	FL	4	41	441,003	9.6	43	0.6
Milwaukee	WI	3	50	600,155	4.5	54	0.3
Minneapolis	MN	5	38	410,939	12.9	40	1.5
Nashville	TN	6	35	654,610	8.8	46	N/A
New Orleans	LA	37	14	389,617	95.0	9	2.9
New York	NY	117	7	8,550,405	13.7	38	9.2
Newark	NJ	22	20	281,944	78.1	13	14.3
Oklahoma City	OK	2	54	631,346	2.6	59	0.1
Omaha	NE	1	59	443,885	1.8	62	0.1
Orlando	FL	3	48	270,934	11.0	41	0.5
Philadelphia	PA	10	31	1,567,442	6.2	49	1.1
Phoenix	AZ	165	5	1,563,025	105.6	7	5.5
Pittsburgh	PA	1	55	304,391	4.8	52	0.4
Portland	OR	27	17	632,309	43.0	19	1.9
Portland	ME	1	58	66,881	16.9	35	1.0
Providence	RI	5	39	179,207	26.5	29	2.4
Raleigh	NC	19	22	451,066	42.7	20	2.9
Richmond	VA	3	47	220,289	13.8	36	0.8
Riverside	CA	32	15	322,424	98.9	8	5.2
Sacramento	CA	40	13	490,712	81.4	10	5.1
Salt Lake City	UT	15	23	192,672	77.5	14	5.4
San Antonio	TX	117	8	1,469,845	79.5	12	3.1
San Diego	CA	303	1	1,394,928	217.6	2	13.7
San Francisco	CA	46	11	864,816	53.5	17	6.9
San Jose	CA	174	4	1,026,908	169.1	3	10.6
Seattle	WA	15	24	684,451	21.2	32	1.3
St. Louis	MO	11	30	315,685	33.4	22	1.7
Tampa	FL	9	32	369,075	24.4	31	1.1
Virginia Beach	VA	1	60	452,745	1.4	64	0.1
Washington, D.C.	DC	25	18	672,228	37.5	21	7.3
Wichita	KS	2	52	389,965	5.5	50	0.3
Wilmington	DE	3	44	71,948	47.9	18	2.1

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

† *This 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. Data were unavailable for cities with "N/A" listed.*[88]

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 with total solar PV capacity installed within Albuquerque as of December 31, 2016.[89] Data were provided in AC watts and converted to DC watts.

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 2016.[90] These data were provided in AC watts and converted to DC watts.

Austin, Texas

Data were provided in spreadsheets compiled by Austin Energy, the municipal utility serving Austin, in DC watts.[91] Installations were listed with their addresses and/or zip codes, allowing us to determine which fell within Austin's city limits. 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.[92] 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 did not meet criteria for inclusion in Austin city estimates. Our current estimate of solar PV capacity within Austin is not directly comparable to the estimate listed in our 2016 edition. Austin Energy erroneously double-counted multiple installations, so the 2016 figure reported was too high.

Baltimore, Maryland

Data for solar PV installations in Baltimore, as of December 2016, were downloaded in a spreadsheet called "Renewable Generators Registered in GATS" through the Generation Attribute Tracking System (GATS), an online database administered by PJM.[93] 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. An update to the GATS database revealed that our 2016 estimate for solar PV capacity in Baltimore was 1 MW too low; the capacity installed in Baltimore as of December 31, 2015 was 7 MW, not 6 MW as reported in our 2016 report.

Billings, Montana

Northwestern Energy, the utility serving Billings, provided the known amount of solar PV capacity installed within the city limits of Billings in DC watts, as of December 31, 2016.[94] The total solar PV capacity installed in Billings as of December 31, 2015, was erroneously reported in our 2015 report as 2 MW, but was in fact 0.2 MW.

Birmingham, Alabama

An estimate of installed solar PV capacity in Birmingham through year-end 2016 was provided in DC watts by Alabama Power, the electric utility serving the city.[95]

Boise, Idaho

The total solar PV capacity of active commercial and residential solar installations in Boise was provided by

Idaho Power, the electric utility serving Boise.[96] Data were provided in DC watts and current as of December 31, 2016. A small number of included installations may have been located in the "area of impact" around Boise. Only installations connected to Idaho Power's net metering program were included.

Boston, Massachusetts

A spreadsheet of solar PV installations in Massachusetts, the "Solar PV Systems in MA Report," was accessed via the Massachusetts Clean Energy Center (MassCEC) online Product Tracking System.[97] We filtered this list to only 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 titled "Solar Electric Programs Reported by NYSERDA: Beginning 2000." We summed "Total Nameplate KW" for installations completed before December 31, 2016 in the city of Buffalo.[98]

Burlington, Vermont

A list of solar PV installations in Burlington at the end of 2016 was provided by the city of Burlington's Electric Department.[99] Capacity figures were listed in AC watts and converted to DC watts.

Charleston, South Carolina

American Electric Power Company provided us with an aggregate sum of solar PV capacity installed in Charleston through the end of 2016.[100] Data were provided in AC watts and converted to DC watts.

Charlotte, North Carolina

A list of solar PV installations in North Carolina was compiled by the North Carolina Sustainable Energy Association (NCSEA).[101] We filtered these data for installations within the city of Charlotte. Figures were listed in both AC and DC watts, so we converted all AC figures into DC units. The NCSEA notes that there were likely systems installed before the end of 2016 that had not been reported at the time of data collection. It is likely, therefore, that the total PV capacity installed in Charlotte was higher on December 31, 2016 than reported.

Chicago, Illinois

ComEd, the electric utility serving the city of Chicago, was unable to provide us with data updated through 2016.[102] Figures listed are up-to-date through December 31, 2015.

Cincinnati, Ohio

Data for solar PV installations within the city of Cincinnati as of December 31, 2016, were provided by Duke Energy, the electric utility serving the city.[103] These data were provided in AC watts and converted to DC watts.

Cleveland, Ohio

We downloaded a spreadsheet of approved renewable energy generating facilities in Ohio from the Ohio Public Utilities Commission's webpage.[104] We filtered this spreadsheet for solar PV installations approved in 2016 in Cuyahoga County, Ohio. To determine which systems were installed in Cleveland, we looked up the corresponding Case Reference numbers on the Ohio PUC's website, which included the addresses associated with the installations.[105]

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.[106] We multiplied the total capacity of solar PV installations within Richland County by the 2015 proportion of housing units located in Columbia to estimate what percentage of this capacity fell in Columbia.[107] Data were provided in AC watts and converted to DC watts. Data were only available through July 31, 2016, so it is likely that systems were added and, thus, that solar PV capacity in Columbia was higher as of December 31, 2016.

Columbus, Ohio

Data were provided in DC watts by the City of Columbus Department of Public Utilities, covering solar PV capacity installed in Columbus as of December 31, 2016.[108]

Dallas, Texas

The North Texas Renewable Energy Group (NTREG), which makes North Texas' renewable energy data available at http://www.ntreg.org/downloads.shtml, provided us with an estimate of solar PV capacity installed in Dallas during 2016.[109] This estimate was provided in DC watts and added to the total Dallas solar PV capacity as of December 31, 2015. The capacities of all commercial installations added in 2016 were provided by the installation companies. The residential capacity was estimated based on the City of Dallas' online permit reports, which include solar installations, but only list capacity for some installations. The remaining installations' capacities were estimated using the listed costs and areas. NTREG assumed an average panel size of 15 square feet and installation cost of $1.50/watt before November 2016 and $1.18/watt during November and December 2016 for these estimates. The average panel size and costs are based on the City of Fort Worth's online permitting data, which does include capacity. NTREG counted the number of panels of many installations using GoogleEarth imagery to refine and confirm the estimates.

Denver, Colorado

The City and County of Denver provided us with the 2015 Community Energy Report for Denver, which contained data on the installed solar PV capacity within Denver at the end of 2015 and was compiled by Xcel Energy, the utility serving Denver.[110] These data were listed in AC watts and converted to DC watts. As these data are only complete through 2015, the total solar PV capacity installed in Denver as of the end of 2016 is likely higher than the figure reported. These data were unavailable at the time of publication of last year's report and, as a result, Denver was excluded in that report. Denver would have ranked 11th in the nation for total solar PV capacity, and 12th for per capita solar PV capacity at the end of 2015.

Des Moines, Iowa

MidAmerican Energy, the energy company that serves Des Moines, provided us with the total solar PV capacity added within the city limits of Des Moines during 2016 in AC watts.[111] We converted this figure to DC watts and added it to the total PV capacity installed in Des Moines at the end of 2015 to calculate total solar PV capacity installed as of December 31, 2016.

Detroit, Michigan

Total installed solar PV capacity within the city of Detroit as of December 31, 2016, was provided by DTE Energy, the electric utility serving the city.[112] Data were provided in AC watts and converted to DC watts.

Fargo, North Dakota

An estimate of solar PV capacity in Fargo as of December 31, 2016, was provided in DC watts by Cass County Electric Cooperative, which serves part of the city.[113] Xcel Energy, which serves the other part of Fargo, did not have any known solar PV capacity installed in its service area to report.[114]

Hartford, Connecticut

Data were provided in AC watts by the Connecticut Public Utilities Regulatory Authority (PURA) in a spreadsheet listing solar facilities approved under Connecticut's Renewable Portfolio Standard.[115] We totaled all solar PV capacity installed in the city of Hartford through December 31, 2016 and converted our figure to DC units.

Honolulu, Hawaii

We estimated the amount of solar PV capacity in urban Honolulu from county-level data released by Hawaiian Electric, the company serving the county of Honolulu (which is coterminous with the island of Oahu).[116] Within the island of Oahu, 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 2010 proportion of housing units located in urban Honolulu to estimate what percentage of this capacity falls in urban Honolulu. [117] 411 MW (capacity in Honolulu County as of December 31, 2016) * 0.4250 (portion of Honolulu county housing units located in urban Honolulu) = 174.675 MW. To compute per capita solar PV capacity for the city of Honolulu, we divided our household-weighted estimate of total installed solar capacity (174.675 MW) by the 2010 U.S. Census population estimate for "Urban Honolulu CDP." 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. We therefore made the conservative assumption that all data were listed in DC watts.

Houston, Texas

Cumulative installed solar PV capacity within Houston city limits as of December 31, 2016 was provided by CenterPoint Energy, the electric utility serving the city.[118] Data were provided in AC watts and converted to DC watts.

Indianapolis, Indiana

Total installed solar PV capacity within the city limits of Indianapolis as of December 31, 2016 was provided by Indianapolis Power and Light, the electric utility serving the city.[119] Figures were reported in AC watts and converted to DC watts.

Jacksonville, Florida

The Jacksonville Electric Authority (JEA), the utility serving Jacksonville, provided us with a spreadsheet of net-metered solar PV installations within their service area through December 2016. [120] We filtered these data for installations within the city of Jacksonville. Capacities were provided in DC watts.

Kansas City, Missouri

Total installed solar PV capacity at the end of 2016 was provided to us in DC watts by Kansas City Power & Light, the electric utility serving the city.[121]

Las Vegas, Nevada

The City of Las Vegas' Office of Sustainability provided us with a spreadsheet of solar PV installations within the city of Las Vegas through December 31, 2016.[122] The capacities were listed in AC watts and converted to DC watts. Las Vegas receives a significant amount of solar energy from its larger metro area, which is not included in the totals of this report. Our totals include the 7,200 systems currently installed within the city limits of Las Vegas, but NV Energy, the utility serving Las Vegas, has 16,800 systems installed throughout its entire southern service territory.[123]

Los Angeles, California

Total installed solar PV capacity in Los Angeles as of December 31, 2016, was provided by the Los Angeles Department of Water & Power, the city's municipal electric utility.[124] The capacity was provided in AC watts and converted to DC watts.

Louisville, Kentucky

Total solar PV capacity installed in the city of Louisville as of December 31, 2016, was provided by Louisville Gas & Electric, the electric utility serving the city, in DC watts.[125]

Manchester, New Hampshire

Eversource Energy, an electric utility serving Manchester, provided us with an aggregate total of installed solar PV capacity within the city limits of Manchester through December 31, 2016.[126] Figures were given in AC watts and converted to DC watts.

Memphis, Tennessee

Total solar PV capacity installed in Memphis as of December 31, 2016, was provided by Memphis Light, Gas and Water, the city's municipal electric utility, in DC watts.[127]

Miami, Florida

The total solar PV capacity installed within Miami city limits as of December 31, 2016 was provided by Florida Power & Light, the municipality serving the city, in DC watts.[128]

Milwaukee, Wisconsin

An estimate of the total capacity of solar PV systems installed in Milwaukee during 2016 was provided by the City of Milwaukee's Environmental Collaboration Office in DC watts.[129] We added this total to the cumulative capacity at the end of 2015.

Minneapolis, Minnesota

Xcel Energy, the electric utility serving the city of Minneapolis, provided us with data on the solar PV capacity of installations within the city as of the end of 2016.[130] These data were reported in DC watts.

Nashville, Tennessee

The total solar PV capacity installed in Nashville as of December 31, 2016, was provided by Nashville Electric Service, the electric utility serving the city, in DC watts.[131]

New Orleans, Louisiana

Entergy New Orleans, the electric utility serving the city of New Orleans, provided us with an estimate of total installed solar PV capacity within New Orleans' city limits as of October 2016, in DC watts.[132] It is likely that systems were added past this time and, thus, that total solar PV capacity within New Orleans was higher at the end of 2016 than our estimate.

New York, New York

Data on solar PV capacity installed within the city limits of New York as of December 31, 2016, were provided by Consolidated Edison, the utility serving the city.[133] Figures were reported in AC watts and converted to DC watts.

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" with city and zip code information, updated through December 31, 2016.[134] Within the Projects List tab, we filtered for solar installations registered in the city of Newark. Data were assumed to be in DC watts.

Oklahoma City, Oklahoma

The total solar PV capacity of net-metered solar installations in Oklahoma City was provided in DC watts by the city's Planning Department via Oklahoma Gas & Electric.[135] To this total, we added 1 MW for an installation at a Veteran's Hospital within city limits.[136]

Omaha, Nebraska

Despite requesting information from a number of sources, we were unable to obtain 2016 solar PV capacity data for the city of Omaha. We therefore listed the most current figure we had available, which was estimated based on 2015 year-end data by the Omaha Public Power District (OPPD), the electric utility serving the city of Omaha. This estimate was provided in AC watts and converted to DC watts. The estimate may include a small amount of solar capacity installed outside of city limits.[137]

Orlando, Florida

Total solar PV capacity installed within the city of Orlando, as of December 12, 2016, and serviced by the Orlando Utilities Commission (OUC) was provided by the OUC's Renewable Energy Manager in DC watts.[138]

Philadelphia, Pennsylvania

Data were downloaded from the Solar Renewable Energy Certificates (SREC) registry PJM-GATS, administered by regional electric transmission organization PJM.[139] These data include installations through December, 2016 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, 2016, in DC watts.[140] The SRP data were broken up by zip code, so, using ArcMap, we multiplied the listed solar PV capacity figures by the proportion of their zip code that fell within the city limits of Phoenix.

Pittsburgh, Pennsylvania

Data for solar PV installations in Allegheny County were downloaded in a spreadsheet called "Renewable Generators Registered in GATS" through the online GATS database administered by PJM.[141] To focus on solar PV installations, we filtered by primary fuel type "SUN" for Allegheny County, PA. The spreadsheet lists solar PV installations by county through December 2016, but does not provide more detailed location data. To estimate the amount of solar capacity installed within the city of Pittsburgh only, we multiplied the total capacity listed for Allegheny County by 0.262, the 2015 U.S. Census estimated proportion of county households located within Pittsburgh.[142]

Portland, Maine

Central Maine Power Company, the utility company serving central and southern areas of the state, provided us with the total solar PV capacity connected to their grid in Portland through the end of 2016 in DC watts.[143]

Portland, Oregon

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 the end of 2016 were provided by the city of Portland's Bureau of Planning and Sustainability in DC watts.[144]

Providence, Rhode Island

Total solar PV capacity within Providence city limits as of December 31, 2016, was provided by the Rhode Island Office of Energy Resources.[145] Figures were given in AC watts, which we converted to DC watts.

Raleigh, North Carolina

The North Carolina Sustainable Energy Association (NCSEA) provided us with a spreadsheet listing solar PV installations in the state of North Carolina.[146] We filtered these data for installations within the city of Raleigh. These data were not complete through 2016, so the city of Raleigh provided us with a list of solar PV projects that were permitted in Raleigh during 2016.[147] The permits did not include capacity data, so we calculated the average capacity of residential and nonresidential systems in Raleigh based on the NCSEA data. We multiplied the number of residential permits (31) by the average residential capacity and the 1 nonresidential permit by the average nonresidential capacity to generate total capacity estimates. We added these estimates to the NCSEA total capacity to generate the total solar PV capacity installed within Raleigh at the end of 2016.

Richmond, Virginia

The Virginia Department of Mines, Minerals and Energy (DMME) provided us with a spreadsheet listing all net metered solar PV and wind energy installations in Virginia through 2016.[148] Within this list, we filtered for solar PV systems, registered to addresses with a "City Name" of "Richmond." The DMME collects capacity data in both AC and DC watts and we were unable to determine specific unit types for individual installations. Because we were informed that the reporting standard for solar PV systems was AC current, we processed all capacity data as AC figures. This list does not include any non-net metered installations, but our DMME contact knew of only one such system in Richmond: a 60 kW system at Virginia Union University, which we added to our total. This system was installed and is owned by Dominion Virginia Power under their Solar Partnership program.

Riverside, California

The total installed solar PV capacity for Riverside was taken from a solar map maintained by the city of Riverside, available at http://www.greenriverside.com/Green-Map-9.[149] Solar capacity data are listed in DC watts and cover installations within Riverside city limits. Riverside Public Utilities provided us with the capacity difference between December 31, 2016 and when we viewed the map on January 16, 2017.

Sacramento, California

Solar PV installation data were provided in a spreadsheet compiled by the Sacramento Municipal Utility District (SMUD), the city's publicly-owned electric utility.[150] A team of GIS analysts at SMUD had pre-filtered the data set to list only installations within Sacramento city limits at the end of 2016. Capacity was given in AC watts and converted to DC watts.

Salt Lake City, Utah

The total year-end 2016 capacity of residential and non-residential net-metered solar PV installations within Salt Lake City limits was provided through the Salt Lake City Office of Sustainability in DC watts.[151]

San Antonio, Texas

Data for total installed solar PV capacity within San Antonio through the end of 2016 were provided in DC watts by the City of San Antonio, Office of Sustainability.[152]

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 city limits as of December 31, 2016.[153] The capacity was provided in AC watts and converted to DC watts.

San Francisco, California

Pacific Gas & Electric, the electric utility serving the city, provided us with a figure of total solar PV capacity installed within San Francisco city limits as of December 31, 2016.[154] Figures were given in AC watts and converted to DC watts.

San Jose, California

Pacific Gas & Electric, the electric utility serving the city, provided us with total solar PV capacity installed within the city limits of San Jose as of December 31, 2016.[155] This figure was given in AC watts and converted to DC watts.

Seattle, Washington

Seattle City Light, Seattle's municipal utility, provided us with the total installed solar PV capacity within Seattle city limits as of December 31, 2016, in DC watts.[156]

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, 2016, in DC watts.[157] The utility company totaled installed solar PV capacity in the following St. Louis zip codes to estimate how much solar PV fell within the city limits: 63101, 63102, 63103, 63104, 63106, 63107, 63108, 63109, 63110, 63111, 63112, 63113, 63115, 63116, 63118, 63139, 63147 and 63155.

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 31, 2016, in DC watts.[158]

Virginia Beach, Virginia

Despite requesting information from a number of sources, we were unable to obtain 2016 solar PV capacity data for the city of Virginia Beach. We therefore listed the most current figure we had available, which was estimated based on 2015 year-end data provided by Dominion Virginia Power, the electric utility serving Virginia Beach. The figure was reported in AC watts, which we converted to DC watts.[159]

Washington, D.C.

We downloaded a spreadsheet listing the number of thermal and PV solar systems installed in Washington, D.C., and the combined capacity of all solar energy systems.[160] This database is maintained by the Public Service Commission of the District of Columbia and lists capacity in DC watts. We multiplied the total solar capacity by the fraction of solar systems that were PV to estimate the capacity of solar PV systems only. Since only systems installed as of November 1, 2016, were listed, it is likely that the capacity was higher at the end of 2016.

Wichita, Kansas

Westar Energy, the electric utility serving Wichita, provided us with solar PV capacity data for Wichita as of December 31, 2016.[161] Data were provided in AC watts and converted to 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 (last entry December 23, 2016) and filtered the list for Fuel Type "SUN" and Generation Units Location "Wilmington". We assumed the capacities were listed in DC watts. Because we knew not all installations listed fell within Wilmington city boundaries, we used QGIS to analyze the data geographically. For installations with zip code information, we multiplied the listed solar PV capacity figure by the proportion of that zip code located in the city of Wilmington. The proportion of total listed solar capacity estimated to be in Wilmington, among all zip-coded items, was 0.379. For installations without zip code information, we multiplied the listed solar capacity figure by 0.379.

Notes

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4. Ibid.

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9. The Solar Foundation, "Fourteen Communities Designated "SolSmart Gold" for Encouraging Solar Market Growth," September 2016.

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15. NC Clean Energy Technology Center, *50 States of Solar- Q4 2016 Quarterly Report & Annual Review*, January 2017.

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19. See note 1.

20. Mike Munsell, "GTM Research: 20 US States at Grid Parity for Residential Solar", *Greentech Media (GTM),* 10 February 2016.

21. See note 15.

22. U.S. National Academy of Sciences and The Royal Society, "Climate Change Evidence & Causes," 27 February 2014, available at nas-sites.org/americasclimatechoices/events/a-discussion-on-climate-change-evidence-and-causes.

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35. Keyes, Fox and Wiedman, LLP, Interstate Renewable Energy Council, *Unlocking DG Value: A PURPA-Based Approach to Promoting DG Growth,* May 2013.

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37. U.S. Census Bureau, Metropolitan and Micropolitan Statistical Areas Main, July 2015, available at www.census.gov/population/metro/data/def.html.

38. After requesting data from a number of sources and finding ourselves unable to procure reliable information, we did not include Cheyenne, Wyoming; Jackson, Mississippi and Little Rock, Arkansas. Also, Sioux Valley Energy reported that no solar capacity was connected to their grid in Sioux Falls, South Dakota at the end of 2016.

39. See note 1.

40. See note 2.

41. This includes all solar PV capacity (rooftop and utility-scale solar installations) within the city limits of each city. It does not include solar power installed in the extraterritorial jurisdictions of cities. See methodology for an explanation of how these rankings were calculated. See Appendix B for city-specific sources of data.

42. See note 3.

43. See note 17.

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45. See note 17.

46. See note 9.

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