

THE PRESENT STATUS OF SOLAR POWER GENERATION IN THE UNITED STATES

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Introduction

This research paper will investigate the present status of solar power generation in the United States with respect to the current solar photovoltaic (PV) installation status of 20 U.S. solar cities. Solar policy incentives provided by federal and state governments, including the 30 percent federal income tax credit (ITC), the Renewable Portfolio Standard (RPS), and the net metering method will be investigated. Several states are currently leading the solar energy installation race due to better policy support, such as California and Arizona.

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Solar Cities in the United States

The report, “Shining Cities: At the Forefront of America’s Solar Energy Revolution,” lists the top 20 cities, which have a total installed solar PV capacity of over 890 megawatts (MW) and represent just 0.1 percent of the land area of the United States but shoulder about 7 percent of the nation’s solar PV capacity.¹ From table 1, one can see that five cities are from the state of California (Los Angeles, San Diego, San Jose, San Francisco, and Sacramento); some others are in relatively close proximity to California with certain geographical advantages for solar energy. The rest are not considered to have strong availability of solar energy in the normal geographical thinking, such as Newark and Boston. Each group of these cities has its own characteristics as to the development of their solar power

Table 1
TOP 20 SOLAR CITIES BY TOTAL INSTALLED SOLAR PHOTOVOLTAIC (PV)
CAPACITY, END OF 2013

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

Source: J. Burr, T. Dutzik, J. Schneider, and R. Sargent, *Shining Cities - At the Forefront of America’s Solar Energy Revolution* (Los Angeles, CA: Environment California Research & Policy Center, 2014).

generation capacity. The following will focus on these solar cities' scale of solar PV systems, investment, and their future development.²

Cities in California—Los Angeles, San Diego, San Jose, San Francisco, and Sacramento: Five California cities are among the top 20 cities nationally for installed total solar PV capacity in the report, “Shining Cities: At the Forefront of America’s Solar Energy Revolution.” All five have great geographical advantages with respect to solar resources, which provide them with higher potential for the use of solar energy. It is possible that the dominant solar position of the state’s five cities may be the result of California’s statewide solar incentive programs. Net metering is one of the ways that California citizens can choose to sell extra solar-generated power gathered in their home-installed PV cells back to utilities so as to earn energy credits. In 2006, the California Legislature created the Million Solar Roofs Initiative, now part of the “Go Solar California” campaign, to direct the investment of \$3.3 billion in small-scale solar electric power systems. The initiative was to increase the state’s solar generation capacity by 3,000 MW, which should cause the cost of solar power to decrease around 50 percent and strengthen the solar electricity generation industry in the state.³ Currently, California has more than 2,336 solar companies and 75,600 employees in its solar supply chain. Additionally, new installation in 2015 of 3,266 MW of solar electric capacity makes the state rank at the top in installed solar capacity in the country with a total capacity of 13,243 MW. The power installed is able to support the electricity needs of 3.3 million homes. The year 2015 saw \$7.268 billion in investments in the state’s solar energy industry. In the future, California’s ambitious RPS, with a goal that all the electricity retailers, public or private, are required to have 25 percent of their sales from renewable energies by the end of 2016 and 33 percent by the end of 2020, which will lead to an even more prosperous solar energy industry in the state.⁴

Los Angeles, California: Los Angeles is the largest city in California with enormous electricity demands due to its huge population. It ranks at the top among the list with the largest total installed PV capacity in the country. The city has achieved a solar electricity price low enough (approximately \$0.10 to \$0.15 per kilowatt hour–kWh) to compete with the traditional utility electricity prices. The initial investment for the installation of a typical 5-kilowatt (kW) PV system is about \$11,000 after subtracting all the incentives including a \$4,000 Los Angeles rebate and an almost \$5,000 federal 30 percent solar tax credit. The investment has an estimated payback period of nine years.⁵

San Diego, California: Sunny San Diego is second on the list with over one-third of San Diego residents getting electricity from renewable energy and nearly 80,000 homeowners choosing to invest in rooftop solar (the highest per-capita rate in California). The installation of rooftop solar panels can help San Diego

residents reduce their electricity bills significantly. Some San Diego residents, who have installed solar systems and participated in the city's net metering programs, achieved a sharp decline in their energy bills from, for example, \$400 per month to a negative \$16 per month.⁶ According to a calculation by the chief energy delivery officer for San Diego Gas and Electric, once a rooftop PV cells system is installed, \$2,000 of the total installation costs will be switched to those who have not yet installed such a device.⁷ Moreover, although the average cost of a typical-sized 5-kW solar panel system may cost around \$20,000 as an initial investment, a San Diego resident can have a maximum expected gain of \$40,000 through the electricity generated from the solar system. To make the installation of solar systems affordable to most of the residents, the city government offers two main solar financing options: (1) Solar Loan and (2) Solar Lease. Both options provide a zero-money-down plan to make the usage of solar power more financially feasible.⁸

San Jose, California: The city of San Jose is the capital of what is often referred to as "Silicon Valley," with ample sunshine and solar technology innovation capability. The municipal government established a series of environmental protection goals, named "Green Vision." One primary goal of this plan relates to the development of solar energy, which is to require that 100 percent of the city's electricity come from clean, renewable sources by 2020 so as to substantially reduce the city's carbon emissions. The city's governors believe one of the major ways to achieve this goal is to use solar power, and it is willing to provide financial help to residents and businesses for the installation of solar power facilities via power purchase agreements. They also want to provide 10 percent of the State of California's one million solar roofs goal.⁹

San Francisco, California: San Francisco stands ninth on the list (table 1). Although San Francisco is sometimes referred to as "fog city," the fog does not substantially impact the city as it develops its solar system infrastructure. Solar panels, for one thing, can still operate in foggy or cloudy weather, since in both situations sunlight can still penetrate these conditions to reach the rooftop PV systems. For another, foggy weather often comes after sunset and disappears before noon, giving the city an average of two-thirds of the daytime in sunshine. The city offers great incentives to solar users and developers. "GoSolarSF" is a program aimed at cutting the fees for solar panel installation for both residences and businesses. The low-income homeowners are also encouraged to install solar systems on their rooftops with a support of zero installation cost from the city.¹⁰

Sacramento, California: California's capital of Sacramento came in fourteenth on the list. The city is very interested in the expansion of renewable energy. With its great geographical advantage of ample sunshine, solar energy has long been one of its focuses. Its commercial and residential property can receive full-scale

financing to build or improve their renewable energy installations, including solar energy. The city also has a community-owned electric service provider, Sacramento Municipal Utility District (SMUD), which built the nation's first PV system in 1984 with enough electricity generated to power 2,200 single-family homes (or 3.2 megawatts). In addition to the supportive solar policies from the state government, the city of Sacramento also developed several incentive programs, for example: (1) the Power Purchase Agreements for city facilities, (2) the Solar-Shares program for community users, and (3) the creation of a Clean/Green technology zone within a 5,000-acre area. All of these programs should let Sacramento reach its 40-MW PV installation goal in accordance with the obligatory share of the state's 3,000-MW PV installation requirement by 2017.¹¹

Cities around California or Having Geographical Advantages of Solar Energy—Phoenix, Honolulu, San Antonio, Denver, Jacksonville, New Orleans, Albuquerque, Austin, Las Vegas, and Raleigh

Phoenix, Arizona: The capital of Arizona and its largest city, Phoenix boasts an ideal nearly 300 sunny days annually for the collection of solar energy. Phoenix city administration offers up to \$1,525 in solar incentives in selected areas (a 10-mile stretch around the Phoenix metro rail service.)¹² Three main solar benefits for its citizens and investors are Phoenix Solar Tax Credits, Phoenix Property Tax Exemption for Solar, and Phoenix Solar Sales Tax Exemption. Two options can be chosen for financing a solar system. The first is a lease agreement for a typical 20 years, during which time the user will pay the developers for the solar PV system. The added payment to the new power bill will be lower than the previous bill. The second option is called a Power Purchase Agreement, offering an option that a developer installs a PV system on a Phoenix citizen's property at no cost by offsetting the existing electricity bill.¹³

When looking at it from a larger perspective, Phoenix's home state of Arizona could be seen as the second largest solar state after California. Arizona uses both PV and concentrating solar power (CSP) methods to promote the generation of solar electricity. The state owns the world's largest operational PV solar-generating facility in Yuma, the Agua Caliente Solar Plant, which produced about 250 MW under perfect sunlight conditions in 2012. They also own a CSP plant for thermal energy storage, the Solana Generating Station, with a maximum output of 280 MW. In the beginning, solar energy was used for heating and pumping water in Arizona almost 200 years ago. Currently, solar generation has been growing rapidly in the state with nearly 955,443 MWh generated in 2012, the year in which the state installed more utility-scale solar facilities than any other state in the country, which resulted in enough solar energy to power 145,500 homes in 2013. Arizona installed 247 MW of solar electric capacity, enough to power 314,000 homes through an infusion of a \$624-million investment toward solar installations, ranking it fifth nationally in the year 2014. The currently installed 2,210 MW of

solar energy in Arizona places the state second in the country in installed solar capacity. More recently, solar tax and incentive programs have been issued by the state government to support its citizens and the 396 companies and almost 10,000 workers in the solar energy industry in Arizona. The net result is that the state's average electricity fees were lower than the U.S. average by 11 percent in residential, 8 percent in commercial, and 16 percent in industrial at the end of 2015.¹⁴ The report, "Empower Arizona—Executive Energy Assessment and Pathways 2014," estimated that the solar industry will realize a 9-cents-per-kWh electricity fee in the next 10 years in the state so as to compete with the electricity being generated from traditional resources.¹⁵

Honolulu, Hawaii: Hawaii's capital, Honolulu, had 271 sunny days in 2013, which greatly helped in furthering the city's development of solar energy. Residential buildings were a large portion of the PV installation permits issued by the city's government in the latest 15 years with an observed PV installation peak occurring in late 2012. The average cost of PV installation in Honolulu for a single-family house between 2009 and 2014 was \$29,300.¹⁶ By providing incentives from the utility, such as feed-in tariffs, and solar tax credits at the county, state, and federal levels, the price of PV solar installation can be cut down drastically and the investment has a very short payback period. The eligibility and rules for each incentive program can vary considerably. According to the state's RPS updated in June 2015, Hawaii should meet its goal of 100 percent of its net electricity sales by the end of 2045 utilizing renewable energy sources. This is the only state that set such a goal with legislative action. Therefore, it can be assumed that Honolulu will keep progressing on its expansion of solar PV systems to help its home state meet this goal.¹⁷

San Antonio and Austin, Texas: San Antonio sits in the south-central part of Texas, ranking sixth among listed top cities with the total amount of installed solar PV capacity.¹⁸ By 2013 the city already had met and exceeded one of its "SA 2020" energy sustainability goals of 1,500 MW electricity generation capacity by 2020. At least 100 MW of solar energy should be included in that portfolio.¹⁹ The city also built the nation's largest solar utility project. The municipally owned utility, CPS Energy, developed a contract with San Antonio-based OCI Solar Power in 2012 to create a 400-MW solar energy capacity by 2016, enough to power nearly 70,000 homes. It was also expected to create over 800 solar-related jobs and a more than \$1-billion solar system construction investment with a \$700-million annual economic impact in the area.²⁰

Austin, San Antonio's brother city, is the capital of Texas, sitting on the eastern edge of Texas Hill Country. It ranked sixteenth among states with the highest total solar PV installation capacity in the country. Many utility-scale solar power plants have been built in the city in recent years. Austin Energy, the eighth largest

publicly owned utility in the United States, is one of them. It provides electricity for about half a million customers and has a service territory of approximately 437 square miles with a population of approximately 1 million. Some solar installation projects have been conducted in the city. For instance, the Austin Energy Project in Webberville was one of the largest PV installation projects in Texas and was completed in 2015 by two companies, Standard Solar and PPC Solar, with an electricity generation capacity sufficient to power more than 3,200 homes.

Looking at it from a larger perspective, Texas is considered by some as a nationally famous solar state. The state has an excellent solar energy supply, ranking first in the nation in solar resource potential. The energy from the high levels of direct solar radiation falling on a single acre of land in West Texas is equal to the energy produced by 800 barrels of oil each year.²¹ To help Texas be more solar friendly, the state offers many incentives and rebates to solar users and developers, for example, property tax rebates and performance-based incentives. However, the net metering method is not mandated by legislation for utilities and the rebates policy could be better in comparison to certain other solar states.²²

Denver, Colorado: Denver, the first “Solar Friendly Community” in the nation, is another city with more than 300 days of sunshine a year. According to the list, Denver ranked tenth in the country for its total PV installation capacity. Besides the advantage from its abundant resource of sunshine, the city also benefits from its solar friendly environment in the state of Colorado, where many solar research centers, solar manufacturing companies, and solar training centers are located. For example, the National Renewable Energy Laboratory is located there. To provide a better way to finance the installation of PV systems, Colorado has an array of financing options for its users and developers, one of which is the Utility Rebate Program, containing a total of 50 subcategory programs for residential, commercial, and business users.²³ By participating in the Solar Benefits Colorado program, users can get a \$500 rebate and a discounted price on solar installations, including all the equipment and permitting costs, of \$3.50 per watt, saving an estimated 15 percent over the standard market rate.²⁴

New Orleans, Louisiana: New Orleans is a Louisiana city on the Mississippi River near the Gulf of Mexico. The city was named as one of the Solar American Cities in 2007 and has achieved a total PV installation capacity of 22 MW in 2013. Although some solar programs are set in New Orleans to make solar power more economical and reachable, the city’s solar development mainly depends on the policies of its home state, Louisiana, where the residents enjoy one of the cheapest electricity rates in the country—\$0.10/kWh—as most of the electricity is generated by burning lower cost fossil fuels. However, if the environmental costs and externalities are added back to that extremely low price, the situation could be different. While the state government does not consider the environmental cost

of their current policy sufficient to provide more attractive solar incentives in Louisiana, it only offers Louisiana Solar Power Tax Credits (\$2,000/kW, up to \$10,000) and 100-percent Property Tax Exemption but does not have any solar power rebates or sales tax exemptions. Moreover, the state's RPS regulation does not require a certain percentage of solar power needed to contribute to that RPS goal, making the future development of solar energy in this state uncertain.²⁵

Jacksonville, Florida: Jacksonville, the largest city in northeast Florida, comes thirteenth on the list as having the largest total PV installation capacity nationally. In recent years, solar-generated power has become more affordable and available in the city. A report released in April 2014 by an environmental advocacy group found that Jacksonville ranked thirteenth among those U.S. cities with the highest number of homes with full-home solar capacity. What is more, the average price for a residential and commercial PV system installation in Florida fell by 37 percent from 2015 to 2016. One of the solar projects, Jacksonville Solar Project, completed in 2013 with a PV capacity enough to power about 1,500 homes, is among the largest solar installations in Florida. However, the overall future development of solar energy in this area is not that promising even though its home state of Florida has the nickname of "the sunshine state." The lack of energy policy protection turns out to be one of the biggest obstacles to the development of solar energy capacity in the state. Florida has no RPS and does not allow Power Purchase Agreements, making investments in solar energy less attractive.

Albuquerque, New Mexico: Albuquerque, the largest city in New Mexico, is located in a high desert area with an average total of 278 days of sunshine. Several large retailers in its home state have gone solar, such as Walmart and Intel. US Foods, a retailer located in the city of Albuquerque, has installed one of the largest corporate PV systems in New Mexico with a total capacity of 426 kW. To achieve the requirement of the state's RPS of 20 percent of electricity generated from renewable sources by 2020, including a 20-percent portion from the sun, the solar energy industry in this area can be forecast to experience considerable growth in the future. According to a report from the Environment America Research & Policy Center released in late 2014, solar PV capacity in the state of New Mexico has increased at a rate of 80 percent annually in consecutive three years from 2010 to 2013. The report predicted that between the years of 2013 and 2025 the state will increase the solar energy portion of its total annual electricity production to 25 percent if its solar installation capacity can keep increasing at only one-third of the 80-percent rate.²⁶

Las Vegas, Nevada: Located in southern Nevada, Las Vegas ranked seventeenth on the list for total PV installation capacity in the country. The city enjoys an average of 300 days of sunshine annually, providing an ample resource for electricity generation via solar panels. A solar research study conducted by the

U.S. Department of Interior indicated that southern Nevada has a potential to generate 6,700 megawatts of electricity from solar resources to power more than 6.7 million homes. A nonprofit, Clean Energy Project, announced in a 2014 report that the state of Nevada has a \$2.3 billion cumulative infrastructure investment for solar electricity generation, including \$220 million for PV installations. However, the altered net metering rate, approved by the Public Utilities Commission of Nevada (PUCN) on December 22, 2015, may cause many large solar companies, such as SolarCity, to leave Las Vegas and the state of Nevada.²⁷ Except for a 30-percent federal tax credit and a \$0.4-per-watt Nevada energy rebate, a monthly \$125 electricity bill in a household with a PV system installed by SolarCity could be decreased to \$40 if the household is a net metering ratepayer.²⁸ Things have changed since PUCN decided to increase the charges for all rooftop solar users participating in net metering, without identifying how long the PV units have been installed and in use. This decision neglected the interests of the current users of cheaper electricity as well as making solar companies feel pressured not to do business in the state.²⁹

Raleigh, North Carolina: Raleigh, the capital of North Carolina, has an average of 217 days of sun per year. This places the city in the second to last position on the list of the top total PV installation capacity cities in the country. In Raleigh, the initial installation of a 5-kW solar PV system will cost about \$20,000. Solar incentives typically come from federal and state government. Although the state provides no rebate program, customers can choose to ask for help from two in-state utilities, Duke Energy Progress (DEP) and Tennessee Valley Authority (TVA). DEP offers a rebate of \$250/kW (\$1,250 rebates for a 5-kW solar panel system) and a \$4.50/kW credit (\$22.50 on average per month) on every monthly bill for its customers while the TVA's customer can get a \$1,000 payment after the installation. For example, after the deduction of the 30-percent federal tax credit and the 35-percent state tax credit, a DEP customer prior to 2016 could have an annual savings of over \$900 with an 8-year payback period until the end of the 20 years expected life-span of the system. According to the North Carolina Renewable Energy Tracking System (NC-RETS), from 2007 to 2014 an estimated \$2 billion has been invested in utility-scale solar projects in the state. Over 450 companies are involved in the solar industry, having provided more than 4,000 jobs in the supply chain of solar power facility construction and research.³⁰ However, with impact from the expiration of the state tax credits at the end of 2015, a relatively low carve-out for solar power (0.2 percent by 2019) in the state RPS, and a below-average electricity price (11 cents/kWh), the future development of solar energy in this area may be restricted.³¹

Other Cities—Indianapolis, New York, Portland, Newark, and Boston

Indianapolis, Indiana: Indianapolis ranked seventh on the list of the highest solar installation capacity nationally. As the capital of Indiana, it has approximately

200 days of sunshine annually. Although the sunshine seems not as abundant as some other solar cities, such as Honolulu, Indianapolis has been recognized as the second best city with the most solar PV installation per capita (127 watts-DC) in the United States by *Forbes* magazine, just after Honolulu.³² The city has built the world's largest airport-based solar farm (150 acres with 31,000 panels) at the Indianapolis International Airport, being able to generate enough electricity to power approximately 1,400 homes annually. From a larger perspective, its home state, Indiana, added 143 MW of electricity generated by solar panels to its electric grid in January 2016, mainly through purchase power agreements. Property tax exemptions and sales tax exemptions have been provided by the state government, but it does not offer solar power rebates or solar power tax credits. Additionally, the state has no mandatory RPS and enjoys a slightly below national average level of electricity fees; both factors increase the uncertainty of the future development of solar PV installation in this area.³³

New York City, New York: New York City is ranked eighth with respect to having the highest total PV installation capacity in the nation. Although solar resources in this area are not as abundant relative to other "sunshine cities," solar PV installations still can create efficient clean energy for New Yorkers during sunny days and even during cold winter days, where limited capacity due to low temperatures will decrease the efficiency of the solar system. Ambitious policies from the New York state government and the federal government increased the popularity of solar energy innovation in the city, which has achieved a 300-percent overall growth rate in its solar industry between 2011 and 2014 after the implementation of the NY-Sun solar PV program administered by the New York State Energy Research and Development Authority (NYSERDA) with a \$1-billion initial investment to build a sustainable and self-sufficient solar industry for the city. Besides the 30-percent federal government investment tax credits and the 25-percent state income tax credit, sales tax exemptions and property tax exemptions are offered as well. Deducting all the incentives and rebates, an average residential solar system cost will range from \$15,000 to \$25,000, a sum of money much less than the estimated \$72,000 energy bill for the next 25 years. Generous government supports have made New York City recently the best place for solar investment in the nation with a payback period of seven years. The goal of installing solar PV systems with a total capacity of 3 gigawatts (GW) by 2023 in New York City from the NY-Sun program also provides ample opportunity for investors to pool money in the solar industry in this area.³⁴

Portland, Oregon: Portland, the largest city in the state of Oregon, stands in the fifteenth position on the list of the highest total solar installation capacity in the nation. The city is located in the Willamette Valley region, where sunny days amount to only 40 percent of the total days per year (or 146 days on average). However, the amount of solar resources in the eastern part of its home state can

compete with those in the state of California. Oregon has an ambitious goal of installing 10 gigawatts (GW) of new rooftop solar PV systems by 2025.³⁵ It has a maximum of \$9,500 in solar rebates and \$6,000 in tax credits, both amounts rank as the nation's best solar incentives. Full sales tax exemption and property tax exemption also are offered by the state government. With the deduction of all the incentives and tax credits from the state and federal government, 80 percent of the initial investment for the installation of a PV system can be recovered. The state's solar industry attracted \$71 million of investment in 2015 under the support of those policies, and the number is expected to grow in the following years. Such investments are important in order to meet the requirement of the state's aggressive RPS that large retail utilities should generate electricity using 25 percent clean energy by 2025 and 50 percent by 2040. However, the utility has the right to miss the goal in certain years if the cost for doing so will exceed 4 percent of its annual revenue. It is anticipated that only a small portion of the clean-energy-generated electricity will come from solar energy.³⁶ Since residents of Oregon have had lower-than-national average electricity prices for a long time due to dependence on burning large amounts of cheap coal, it is hard to predict when solar electricity prices will become competitive with traditional electricity prices.

Newark, New Jersey: Newark, the largest city in the state of New Jersey, has slightly more than 50 percent (or 183) sunny days per year. It stands in eighteenth position out of the top 20 cities with the highest total solar installation capacity in the United States. Solar policies in this area are not as extensive as those of its neighbor New York City due to a lack of tax incentives and rebates for solar projects. Only sales tax exemptions and property tax exemptions have been offered. Instead, Solar Renewable Energy Certificates (SREC) have been developed as an interconnected method between utilities and customers who have solar PV installations in their homes to save money while using solar energy. For homes with solar installations, each 1,000 kWh of electricity generated above the homeowner's needs represents one SREC. While the price of an SREC is determined by the marketplace, it has fluctuated from \$300 when the program began to about \$183 in early 2015 in Newark.³⁷ Through purchasing the SRECs from solar customers, New Jersey retail electricity utilities can then apply them to their deficits of electricity that should be generated from renewable resources as mandated by the state's RPS by selling 20.38 percent of their electricity from renewable energy by 2028. Meanwhile, solar customers can get payments from selling SRECs to the utilities to offset their solar system installation costs.³⁸ Currently, the state has installed 1,632 MW of solar PV systems with almost half a million dollars being invested in the solar industry.

Boston, Massachusetts: Boston, the capital and largest city in Massachusetts, has approximately 182 sunny days per year. It was at the bottom of the list of the top 20 cities with the highest total solar PV installation. In 2009, the city launched

a service program, Renew Boston, to promote the usage of alternative energy in the city by providing financial help and creating related job opportunities to the residents, businesses, and institutions.³⁹ Residential users can enjoy a renewable energy income tax credit to cover about 15 percent of the installation fee, with a cap of \$1,000, while businesses enjoy a 100-percent sales tax exemption. Similar to the state of New Jersey, Massachusetts uses SRECs as a primary incentive method to support renewable energy users with a savings of approximately \$1,700 for a typical 5-kW size rooftop solar system by selling SRECs to utilities during 2016. Currently, \$4 million in government funds will be invested in corporate, residential, and non-profit PV system development every year under the Commonwealth Solar II Rebate Program. In this case, the typical 5-kW-sized PV system can earn a \$5,000 rebate, with a doubled amount for new users with moderate household incomes (not greater than 120 percent median income).⁴⁰ Massachusetts' aggressive RPS policy requires solar and other similar renewable energy resources to contribute 15 percent of the total electricity generated in the state by 2020 through 1,600 MW of additional PV installation capacity. That percentage is mandated by the state government with a 1-percent increase each year thereafter without an expiration date. Currently, 1,020 MW of solar PV systems have been installed in the state and the year 2015 witnessed an \$803 million investment in solar installation with several large companies going solar, including Walmart, Staples, Bed Bath and Beyond, and IKEA.

Environmental Concerns and Solar Energy Policies

(1) The Potential Environmental Benefits Due to Solar Power Generation: Solar energy is considered as one of “the best systems of emissions reduction” by the Environmental Protection Agency. The U.S. government has spent many millions of dollars on solar development around the country to take advantage of the benefits from this type of clean energy. Developing solar energy to generate electricity instead of burning fossil fuels can greatly reduce the emission of greenhouse gases. This approach should then lower the rate of global warming and decrease the frequency of extreme weather phenomena. It is estimated that 16.8 million metric tons of carbon dioxide emissions will be eliminated each year under the current installation scale of solar PV systems in the United States.⁴¹

Solar energy has a much better fuel source than most other types of electricity producing fuels. Originating from the sun, this source of energy is easy to acquire and will be available for a long time. It is estimated that the sun will last for another 6.5 billion years. Therefore, it should be able to support the increase in solar energy production, thereby solving the potential problem of possible energy shortages in the future. The solar panels for the storage of solar energy will emit no hazardous materials to the air as they operate. Greenhouse gas emissions will be greatly

reduced with advanced solar technologies. Solar energy systems can be set up on the rooftops of houses and buildings, excluding environmental drawbacks due to the clearance of vegetation for providing enough room to build large traditional power plants. Finally, in addition to zero air pollution emissions, solar electricity systems will not create sound pollution since they operate and transmit the produced electricity with no noise. Although solar energy may have some disadvantages, such as high initial installation costs, the system efficiency uncertainty due to climate and weather as well as the day-and-night shift, periodic replacement of heavy solar batteries, etc., these are mainly financial problems rather than environmental ones.⁴²

(2) Federal Government Policies Review: A report from the National Climate Assessment indicates that the warming climate and the increasing natural disasters over the past 50 years are primarily caused by human-involved burning of coal, oil, and gas.⁴³ The statistics from the EIA showed that in 2015 two-thirds of the electricity in the United States was generated by burning fossil fuels with only 0.4 percent coming from solar power.⁴⁴ To fight climate change, renewable energy has been largely implemented nationwide; especially for wind and solar, which are clean as well as fairly easy to access. Over the past five years, more than \$150 billion from taxpayers has been put into a pool of solar subsidies in the United States, according to the Taxpayers Protection Alliance. Massive federal support for solar energy is reflected through approximately 350 different federal initiatives with 20 federal agencies having participated in 1,500 solar projects. The most active participant is the Pentagon, which has developed 63 solar programs. The next most active participant is the Interior Department, with 37 programs, and next the Department of Energy with 34 solar programs.⁴⁵ However, the renewable energy policy from the Trump government could mitigate the efficacy of the existing clean energy facilities on decreasing the rate of the warming effect and frequency of natural disasters. Several proposals for funding reductions in renewable energy development have been announced. For example, the Environmental Protection Agency (EPA) would face a one-third budget cut in the future.⁴⁶ Half of the national funding for the Office of Energy Efficiency and Renewable Energy (EERE) would be slashed.⁴⁷ Protecting the environment was no longer first priority in the new administration's agenda. "An America First Energy Plan," from the White House, demonstrated that its passion was turned to traditional energy exploration instead of renewable energy development.⁴⁸ However, there is little to suggest that the new administration's energy policy changes will manifest into significant effects on current solar energy policies.

Investment Tax Credit: The Investment Tax Credit (ITC) is one of the most effective financial support mechanisms initiated from the Energy Policy Act of 2005. This program has had several extensions to boost the usage and construction of solar PV systems. It has a 30-percent federal tax credit for the installation and development of solar systems on residential and commercial properties. Residents

can enjoy an income tax exemption accounting for 30 percent of the total solar PV installation cost and commercial users and solar businesses also can use the tax credits to increase income. The ITC, which was to expire at the end of 2016, recently passed a three-year-plus extension to 2019.⁴⁹ The rate will remain at 30 percent during these three years and then decline steadily after the extension to 10 percent for commercial properties and zero for residential homeowners. Studies show that the extension will lead to an additional 25 GW of solar PV systems to be installed by 2020. Eventually, this situation could be even better since the estimates indicate that, if the ITC were to be extended to five years (through 2021) at a 30-percent rate, 3.5 percent of the electricity (95 GW) should be generated by solar resources. This would be enough to power 19 million homes in the nation and to cut the carbon dioxide emissions by an additional amount of 100 million metric tons. This would have an effect similar to closing 26 coal-fired power plants or making 20 million cars disappear from the road.

SunShot Initiative: Another federal government funded program, the SunShot Initiative, announced in early 2011 by the U.S. Department of Energy, provides \$270 million per year.⁵⁰ This program was intended to make solar energy cost-competitive with other forms of electricity (\$0.06 per kWh versus \$1 per watt without incentives by 2020) by reducing all solar PV system costs, including hard costs for components and subcomponents, installation and maintenance costs, and soft costs related to rules and policies from governmental and commercial institutions. The program mainly focuses on five aspects: PV, concentrated solar power, soft costs (or balance-of-system costs), systems integration, and technology to market. The forecast effect of the program is that 14 percent of the electricity produced nationally in the United States will be generated from solar electric systems by 2030 and 27 percent by 2050. The current result is that the price of solar electricity has dropped from \$3.80 per watt in 2011 to \$1.64 per watt in 2015 after five years of effort. Residents in 14 states across the nation, including California, Hawaii, Texas, and Minnesota, are now able to use solar electricity at a price similar to that from traditional energy resources with the help of ITC. Moreover, residential solar PV systems in 42 of America's 50 largest cities can provide lower cost electricity than the traditional local utilities for customers. The investment in a typical-sized solar PV system in 46 of the 50 largest cities turns out to be more profitable than that of a typical stock market index fund. Except for providing benefits for U.S. residents with clean energy, the SunShot initiative also strives to rebuild the nation's position in the world's solar market and to strengthen U.S. energy independence by continuously improving the efficiency of its solar PV systems. For example, the SunShot National Laboratory Multiyear Partnership (SuNLAMP) funding program, a sub-program of the SunShot Initiative, is aimed at addressing the most critical technology barriers so as to make solar electricity more stable as well as affordable.⁵¹

(3) Selected State Solar Policies Review: Of the top 20 Solar Cities reflected by total installed solar PV capacity at the end of 2013, 15 states are represented in the listing. As shown previously, not all of these states have a geographical advantage for developing solar energy, such as Massachusetts and New York. However, effective solar policy support makes solar energy popular in those areas as well. The Environmental Protection Agency recognizes the fact that states with the greatest geographic advantages for solar system development are located in the southwestern and western parts of the country, including Arizona, California, Colorado, New Mexico, Nevada, Texas, Utah, and Wyoming. It also was observed that almost all of the solar PV systems in the United States are concentrated in the southwest and northeast, including Arizona, California, Connecticut, Massachusetts, Maryland, New Jersey, and New Mexico. Wide-ranging state solar financial support methods lead to varied results with respect to solar system installations. Primary state policies include RPS, net metering, feed-in tariffs, interconnection standards, property assessed clean energy, public benefits funds for renewable energy, output-based environmental regulations, and financial incentives. RPS and net metering are the two main policies mandated by the majority of states in the United States.⁵²

Renewable Portfolio Standards (RPS): These standards, mandated by individual states, set a minimum percentage requirement of renewable energy sold by retail electricity utilities with an objective to stimulate the renewable energy market and technology development so as to provide affordable electricity generated from clean energy. Details of these programs vary among the 29 states plus Washington, D.C., which have mandated RPS goals with another eight states having voluntary ones. Since 2007, 14 states have added solar-specific mandatory targets in their RPS goals. However, RPSs will create more benefits to the environment and help boost the economy by providing more jobs and new markets. It is recognized that the revenue of electric utilities may be impacted due to the adoption of new forms of energy, perhaps resulting in increasing costs and market uncertainties. To address this potential problem, the RPS policy indicates that utilities can take a form of alternative compliance payment to meet the goals, instead of extending a certain cost cap such as a percent of utility revenue requirements. The Renewable Energy Certificate (REC) is a common alternative compliance payment method for recording the renewable energy provided by the electricity suppliers through a regional tracking system, such as the North American Certificate Tracking System. One megawatt-hour equals one REC. Retail electricity suppliers can buy RECs from other renewable electricity generation facilities, such as a homeowner's solar PV system, to meet its RPS requirement rather than producing renewable electricity themselves. The price of an REC depends on the free market and the amount of financial penalty the utilities should pay for missing RPS requirements. The solar REC (SREC) programs in some states have successfully

created profitable renewable energy markets in several states, making the investment in solar facilities more profitable than some other traditional investment channels.⁵³ For example, Massachusetts launched a SREC-II program to meet its 1,600 MW solar installation capacity by 2020 in 2014, leading to one SREC with a bidding price fluctuating from \$250 to \$300 in the latest year.⁵⁴

Net Metering: Net metering is a billing mechanism that allows residential and commercial customers to sell to their electric utility the excess electricity generated by their distributed generation (DG) systems so as to offset their total electricity fees. DG systems are small-scale, on-site power sources located at or near customers' homes or businesses with a connection to the local electric grid. More than 600,000 American homes and businesses had installed on-site solar distribution systems by the end of 2014 with a 50-percent annual residential market growth rate in the latest three consecutive years.⁵⁵ By far, solar rooftop installations are the most common type of DG system that allows customers to use a net metering method to lower their overall electricity bill. Solar net-metered customers can sell the extra amount of electricity, after meeting their needs during the day, to the connected local electric grid and buy power when their own solar rooftop installation system cannot provide enough power during the night or during adverse weather conditions.⁵⁶

Net metering has been authorized as a statewide policy by 44 states, Washington, D.C., and four U.S. territories. To help utilities meet their state's specific renewable energy portfolio requirements, they can buy electricity from residential distributed clean energy generation systems via the net metering method. In consideration of solar net-metering policies, different states have varying net metering approaches. Recent popular trends related to net metering include the increase of fixed charges and the creation of utility-led residential solar PV generation business models. The fixed charges have set a limited amount of the electricity bill that can be offset through a residential solar PV generation system. The increase in fixed charges, usually accompanied by a decrease in variable costs (per kWh rates), will make the cost of using solar energy more expensive for individual residents with small amounts of energy consumption while being less expensive for large energy consumers. By the third quarter of 2015, 18 states had proposed an increase in fixed charges. The average existing monthly fixed charge for residential consumers is \$9.61 among these states while the average proposed number is \$15.76 with an average increase rate of 70 percent. Another popular trend is the creation of utility-led residential rooftop solar programs, a business model letting utilities directly participate in the distributed solar energy market. The financial impact on solar customers from net metering varies in regard to different programs. These programs have the potential to help utilities meet the renewable energy portfolio targets by growing their renewable energy capacity, increase revenues by retaining their original customers, and lowering peak-hour

power generation pressure. For example, a 2014 pilot program conducted by Arizona Public Service (APS) and Tucson Electric Power provided each customer with a monthly electricity bill credit as a “roof usage fee” by the APS for its solar panels. Before the utility-led residential rooftop solar model, the utility-led community solar model was the main mechanism for utilities to enter into the distributed energy market. In such cases, consumers who are not permitted to install solar PV systems as an individual due to living or financial factors can share the benefits of solar installations with other residents in the same community.⁵⁷

Conclusion

In recent years, the solar energy market in the United States has been experiencing a continuous growth through the support of various federal and state government policies. For example, federal ITCs, state RPSs, and net metering provide ways for customers to develop affordable solar electricity. The U.S. solar energy market is divided into three categories (residential, non-residential, and utility), mainly made up by 20 states. Of this number, 10 states contribute approximately 90 percent of the nationwide PV installation capacity. The year 2015 realized the fourth consecutive residential PV market annual growth rate greater than 50 percent, with six states (Arizona, California, Massachusetts, Nevada, New Jersey, and North Carolina) having more than 1 GW direct current in cumulative solar capacity. The state of California alone has contributed nearly 50 percent of new annual residential PV installations. The utility PV market, a fundamental contributor to the growth of the whole solar energy market, accounted for 57 percent of the total solar PV installation capacity in 2015. North Carolina and California are the two states with an annual addition of more than 1 GW direct current of utility PV installations in 2015. With the exception of California, the non-residential solar market in the rest of the country showed a stagnant picture due to the lack of incentive funding and large-scale solar energy development projects.

NOTES

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