

Case Study: Understanding Solar Power Adoption in the United States

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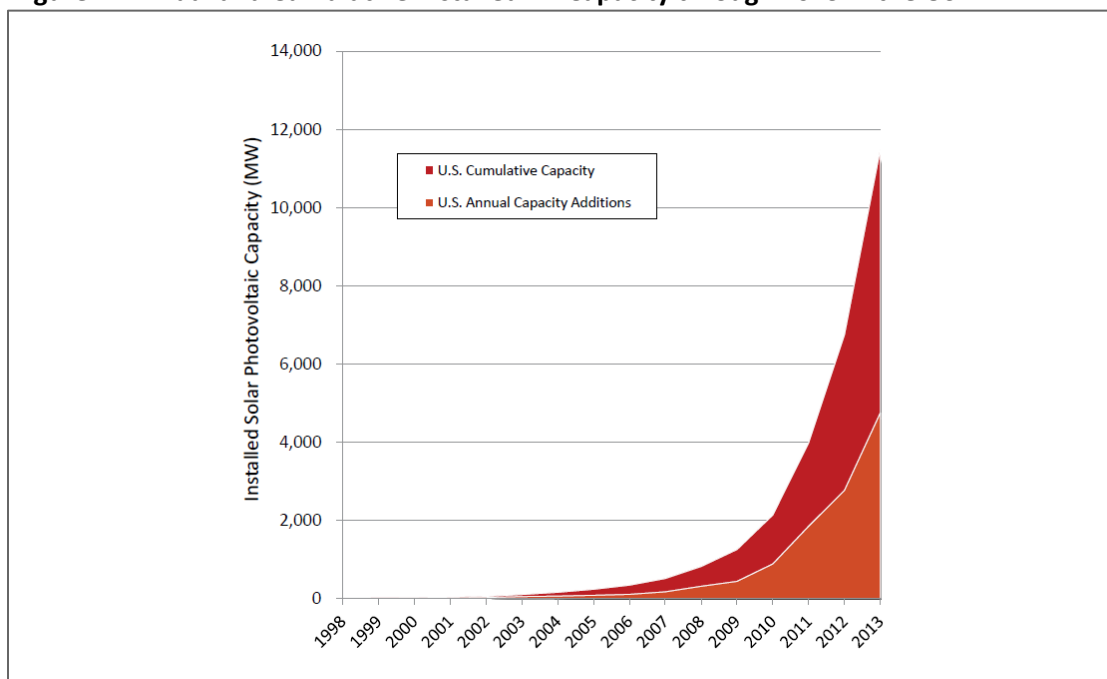
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The Growth of Solar Energy

Solar energy use has grown substantially in recent years both in the United States and globally. The first solar battery was developed in 1954 by Bell Labs, and large scale solar plants began popping up in the 1980s and 1990s, but it wasn't until the early 2000s that solar technology gained significantly in popularity. Two factors made this possible: a) new financial models that made solar technology more affordable and b) government subsidies for solar energy.

In the United States, installation of solar panels hit a peak in 2013. According to a report from the Environment America Research & Policy Center, "The United States has more than 200 times as much solar photovoltaic (PV) capacity installed today as it did in 2002" (Burr et al., 2014, 4). Figure 1 below shows this growth in terms of cumulative capacity and additional annual capacity. In 2013 the United States saw a 41 percent increase in solar installations over 2012. Solar energy accounted for 29 percent of all new electricity generation capacity in 2013, up from just 10 percent in 2012. Solar is the second largest source of new electricity generating capacity behind natural gas (SEIA c, 2013).

Figure 1: Annual and Cumulative Installed PV Capacity through 2013 in the US



Source: Burr et al. "Shining Cities At the Forefront of America's Solar Energy Revolution." Environment Colorado Research & Policy Center and Environment America Research & Policy Center. April 2014. Page 4.

Solar installation in the United States continues to boom, and there are now over 13,000 MW of total solar electric capacity operating in the U.S., enough to power more than 2.2 million average American homes. It is predicted that close to 6,000 MW of solar PV will come online in 2014, representing a 26 percent growth over the year before. New solar electric capacity added in 2014 should help generate enough clean energy to power an additional 1.13 million American homes (SEIA c, 2013).

These trends are putting the U.S. on a path towards an economy fueled principally by renewables. According to the U.S. Department of Energy's National Renewable Energy Laboratory (NREL), renewable electricity generation from technologies that are commercially available today, in combination with a more flexible electric system, are more than adequate to supply 80 percent of total U.S. electricity generation in 2050 while meeting electricity demand on an hourly basis in every region of the country (NREL, 2013, 7). On a larger scale, global renewable capacity is expected to triple by 2035, supplying close to one-third of electricity worldwide, fueled by the increasing cost competitiveness of wind and solar technologies, and by the deployment of renewables in emerging markets (NREL, 2013, 6-7).

Why are we seeing such growth? Solar energy certainly has many advantages over traditional fossil fuel-based energy. Fossil fuels are finite resources and their extraction damages earth's ecosystems. When burned as fuels, fossil fuels emit greenhouse gases that cause climate change and disrupt human settlements, agriculture and infrastructure. Solar energy does not release harmful greenhouse gases (beyond the production of the panels themselves), and can be utilized either on or off the electricity grid. The solar energy industry is also an important local job creator, and it is generally less vulnerable to price manipulations and the type of politics that have more than doubled the price of many fossil fuels in the last decade (Whitburn, 2012). Despite these many advantages, there are a number of technical and regulatory challenges associated with solar energy use that limit its further deployment.

Challenges

Solar energy does not easily connect to the current electrical grid, nor is it easy to store for use at later times. Solar energy conversion isn't as efficient as conversion of traditional, fossil fuel-based energy. Renewable energy projects tend to be expensive and risky investments, and solar energy panels can be difficult to install, especially for renters and owners of small homes and businesses. Even with solutions such as net metering and community solar, new problems arise. According to a 2010 *New York Times* article, if the United States is to catch up with other countries that are pursuing renewable energy, "it must overcome obstacles like a fragmented, outdated energy grid poorly suited to renewable energy; a historic reliance on plentiful and cheap supplies of fossil fuels, especially coal; powerful oil and coal industries that often oppose incentives for renewable development; and energy policy that is heavily influenced by individual states" (Rosenthal, 2010).

1. Solar Storage

One of the biggest obstacles to deploying solar energy is its incompatibility with traditional energy infrastructure. Today's power grids aren't able to store energy, and solar energy is intermittent, meaning it may generate more or less than is needed at any given time (Williams, 2014). Peak solar generation times do not always coincide with peak electricity use, so solar energy must be able to be stored for use at later times. Solar energy must also be sourced elsewhere at night or during winter months, but battery technology thus far has not been able to store energy on a large enough scale (Whitburn, 2012). According to Kate Galbraith, an environmental columnist for the *New York Times*: "cheap, large-scale energy storage is considered the holy grail of renewable power because it would allow wind and solar farms to provide constant energy to the electric grid" (2013). Better storage will allow for increased flexibility of energy use, and can facilitate increased use of transmission lines that connect the resource to the grid (National Research Council 2010, 12). Technical advances in infrastructure can help solar and other types of renewable energy to be utilized on a scale well beyond their current capacities.

2. Conversion of Solar Energy

In addition, the energy conversion process from solar is inefficient when compared to traditional sources of energy. Most solar panels convert less than half of the sunlight that reaches them into electricity, and even the best panels on the market have conversion rates of only 35 percent (Williams, 2014). More efficient solar cells are expensive to produce, and while a number of technologies are being developed to overcome these challenges, most are too expensive to use. Even with the costs of solar declining generally, it is still more expensive to produce electricity from the sun than from traditional fossil fuel based sources (Whitburn, 2012).

3. Connecting to the Power Grid

Traditional electrical systems are centralized, where electricity is generated at a large-scale power plant and then transmitted (often over long distances) to customers. Solar energy, in contrast, is a type of distributed energy, which refers to the generation of electricity from sources that are at or near the point of consumption. This type of production can reduce the amount of energy lost in transmitting electricity and reduce the size and number of power lines needed (NREL, 2012). Distributed generation can provide greater local energy independence and reliability, and is often combined with load management and energy storage systems to improve the quality of electric supply. However, there are a number of technical, temporal, and spatial restraints to integrating electricity onto the grid in a way that ensures a reliable supply, and there are a number of information barriers for customers. One solution is a “smart grid” that incorporates data across the transmission system and optimizes delivery, efficiency and conservation. This requires upgrading the existing grid to incorporate these new technologies.

In addition, one of the main obstacles to decentralized (distributed) renewable energy is the varied set of rules governing access to the power grid by states and utility territories. Barriers include the challenge of raising capital, formulating a legal structure that allows for local ownership, and battling against utilities that may be hostile towards local generation because of its threat to the market share (Farrell, 2013). These obstacles remain even for those models of renewable energy transmission that are more centralized, such as large concentrated solar farms that are built in desert regions, far from cities and areas where power is actually needed.

4. Financial Hurdles

In addition to these technical challenges, there are financial hurdles both to install and to invest in solar technologies. Solar energy installations can be especially costly for small home and business owners. People who rent their housing or office space have no incentive to install solar (because they do not own the building, though they would benefit from lower energy bills), and often multi-family residences and apartment buildings don't meet the requirements for solar installation. On the investment side, renewable energy projects are typically smaller, more complex, and riskier than traditional energy investments. Even with the costs of solar energy declining overall, according to Bloomberg New Energy Finance, investments in clean energy have actually fallen by 21 percent since 2011 (Williams, 2014). For these reasons, solar energy research, development, and installation projects often require government policies and incentives.

5. Net Metering Issues

Net metering enables residential and commercial customers who generate their own renewable energy to feed back onto the grid the electricity that they don't use onsite (EPA, 2006, ES-17). Net metering defines processes and technical requirements for smaller projects and requires that electric utilities buy unused electricity back from customers at retail rates. With net metering, the meter runs backwards when a residential solar panel produces more electricity than is being used, and customers can get fair

credit for power they put back on the grid for others to use. These type of grid standards are important for solar to connect to the electric grid, and can reduce the uncertainty and delays that these systems sometimes encounter.

While participation in net metering is increasing rapidly across the country, the percentage of customers participating remains well below 1 percent (EIA, 2012). Net metering is also one of the more controversial issues surrounding solar energy. Utility industry trade associations, the fossil fuel industry and fossil fuel supporters have been pushing against net metering policies because they view net metering policies as lost revenue. They argue that solar customers do not pay their share of electricity costs. Groups such as the American Legislative Exchange Council (ALEC) and some electric and public utility companies have proposed resolutions to weaken net metering policies. They argue the need for a fixed grid charge in order to restructure crediting mechanisms so that everyone who uses the grid pays to maintain it (ALEC, 2014). This could mean individual solar electricity generators being charged for connection to the grid.

U.S. Solar Energy Policy

Under the Obama Administration, the U.S. energy policy is often described as “all of the above” because it includes a variety of strategies involving multiple sources of energy, such as expanding domestic natural gas and oil production, promoting biofuels, supporting renewables, and investing in carbon capture and storage for “clean coal.” However, “all of the above” is more of a public relations phrase than real policy or strategy, as it refuses to acknowledge the need to make choices. As Jeffrey Ball, formerly *The Wall Street Journal’s* environment editor and scholar-in-residence at Stanford University observed: “As a statement of fact, ‘all of the above’ neatly describes the nation’s energy shift. But as a summation of strategy, it’s so general as to be meaningless. It’s so opaque that it’s succeeding mostly in angering all the special interests involved” (Ball, 2014).

This is not to say that the federal government isn’t taking action in favor of renewables, such as solar. Prior to the 2000s, solar technology was not advanced enough to allow for solar energy policies at the U.S. federal level. However, in 2005, Congress passed the Clean Energy Policy Act which, among other things, created a loan guarantee program for the Department of Energy to support “innovative clean technologies” that would otherwise be unable to receive private funding due to high technology risk. The program provides guarantees to private lenders such that if a company defaults on a loan, the government will repay the outstanding balance. This program didn’t really begin allocating loans until 2009, after President Obama took office. The White House’s 2011 Blueprint for a Secure Energy Future laid out its goals for fostering renewable energy, by making critical investments in a range of renewable energy industries (The White House, 2011).

The 2005 Clean Energy Policy Act also created a 30 percent solar investment tax credit (ITC) for commercial and residential solar systems (provided through Section 48 of the Internal Revenue Code). This credit has been an important federal policy mechanism to support solar energy deployment; the amount of solar grew by 77 percent annually between the time the tax credit was enacted and 2012 (SEIA a, 2014). “As a stable, multi-year incentive, the ITC encourages private sector investment in solar manufacturing and solar project construction” (SEIA d, 2014). The ITC is currently scheduled to expire at the end of 2016, and there is no clear consensus on whether or not it will be extended. Currently, developers can expect to offset 40 to 45 percent of the installation costs, which for some, is the difference between staying in business and folding. “It appears the only solar developers likely to garner the attention of institutional investors during the final two years of the subsidy will be the ones able to

make compelling arguments that they will survive the subsidy's elimination and remain able to asset-manage these long-term investments" (Jensen, 2014).

The 2009 American Reinvestment and Recovery Act (also known as the stimulus bill) further amended the Clean Energy Policy Act and expanded the loan program. Under the stimulus bill, the Obama Administration appropriated 90 billion dollars for clean energy, for projects ranging from investing in smart grids to helping homeowners with energy efficiency upgrades (US DOE, 2012). From these funds, the Department of Treasury and Department of Energy have funded more than 20,000 projects nationwide for clean energy manufacturing and production.

The impact of the American Recovery and Reinvestment Act was particularly notable for clean technology. From the period 2002-2008, federal support for clean technology (across agencies) totaled an estimated \$44 billion and grew to \$150 billion from the period 2009-2014 (Banks, 2011, 40). Despite these gains from the stimulus, funding has decreased since the peak in 2009 when the budgets for clean tech totaled \$44.3 billion. In 2014, budgets dropped to roughly \$11 billion— a 75 percent decrease in funding for solar, wind, and other clean technologies (Jenkins, 2012, 6). This continued to decline as subsidies expired. By the end of 2014, 70 percent of 2009 programs will have expired and non-stimulus funding will have declined by 50 percent (Jenkins, 2012, 4, 6).

As of 2012, under the expanded loan guarantee program, the Department of Energy reported \$34.7 billion in taxpayer-subsidized loan and partial loan guarantees to fund 33 clean energy projects, including the now well-known company Solyndra (Institute for Energy Research, 2012). Solyndra, a solar panel company founded in 2004, was given a \$535 million loan guarantee in 2009. However, when the price of polysilicon, the primary material in its solar panels, fell sharply, Solyndra found itself unable to make its loan payment. The company filed for bankruptcy in 2011 and laid off over 1,000 employees (Weiner, 2012). This failure left the government, and ultimately taxpayers, bearing the cost of the loan. Solyndra had already received substantial media attention as the administration's energy policy show horse before filing for bankruptcy. The company became an example for harsh criticism from opponents of government support for renewables.

While fossil fuels receive substantial government tax expenditures, public and media attention is nevertheless focused on subsidies and failures of renewable energy support, such as Solyndra's bankruptcy. Although Solyndra is the most well-known example of a failed government-backed renewable energy company, there are others as well. Evergreen Solar Inc. closed its manufacturing plant in 2001, after accepting \$58 million in state subsidies (Murphy, 2011). Abound Solar, a solar panel manufacturer, received a loan guarantee of \$400 billion from the DOE, but filed for bankruptcy liquidation in 2010. However, "since its creation, the loan office has lost \$800 million in taxpayer dollars— just two percent of the total \$34.4 billion portfolio, and well within the bad loan margin of just about any private bank" (Gallucci, 2013).

The federal government also has programs to drive research and innovation in the solar sector. Most recently, the Department of Energy's SunShot Initiative, announced in February 2011, drives research, manufacturing and market solutions to increase solar energy resources and make them more affordable and accessible. This is a key part of the President's Climate Action Plan. This initiative has funded more than 350 projects in photovoltaics, concentrating solar power, balance of systems costs (those related to all components of the photovoltaic system beside the panels), and systems integration, over a range of organizations including private companies, universities, and national labs. Overall, the goal of the initiative is to drive down the cost of solar energy— specifically to \$0.06 per kilowatt-hour (US DOE,

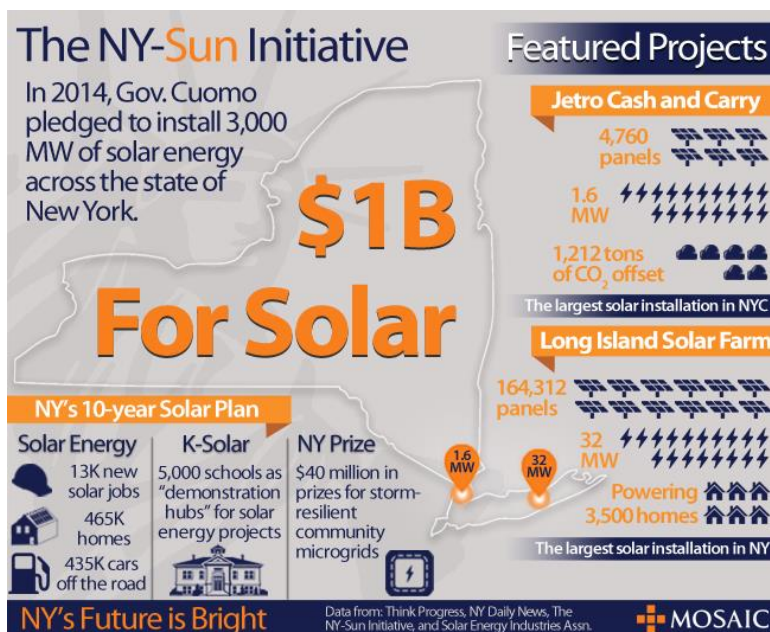
2014). Achieving this kind of cost reduction, “could result in solar energy meeting 14% of U.S. electricity needs by 2030 and 27% by 2050” (US DOE, 2014).

The ultimate goal of these types of measures is to reduce the cost of renewable energy so much that it becomes cost-competitive with fossil fuel based energy – also known as ‘grid parity.’ Grid parity has been achieved in some major European countries; according to the consulting firm Eclareon, commercial solar power hit grid parity in Italy, Germany, and Spain in 2013, meaning that commercial solar now competes with retail electricity in these countries (Shahan, 2014). According to a recent article in the *Washington Post*: “As grid parity becomes increasingly common, renewable energy could transform our world and slow the effects of climate change. Advances in solar panels and battery storage will make it more realistic for consumers to dump their electric utility, and power their homes through solar energy that is stored in batteries for cloudy days” (McFarland, 2014).

Solar Energy Policy in New York State

Despite federal support for solar energy with subsidies, tax credits and loans, solar energy installation and deployment is largely regulated at the state level. New York State has shown a commitment to solar energy through financial incentives, research and development, increased installation of solar panels and increased manufacturing of solar technology statewide.

The most widely recognized solar program in the state is the New York Sun Initiative (NY-Sun), a public-private partnership intended to drive the growth of the solar industry in New York, championed by Governor Andrew Cuomo in 2012. The Initiative brought together and expanded existing programs administered by the New York State Energy Research and Development Authority (NYSERDA), Long Island Power Authority (LIPA), and the New York Power Authority (NYPA), to ensure a coordinated and well-funded solar energy expansion plan. The Initiative planned to make solar energy more affordable for residents and



Source: <https://joinmosaic.com/blog/new-york-solar/>

businesses in order to increase the amount of installed customer-sited PV capacity. NYSERDA and NYPA would provide at least \$40 million dollars in an effort to promote research into reducing the overall equipment and installation costs so that in the future solar energy would be competitive with other forms of electricity and require no government subsidies (Cuomo, 2012). In January 2012, Governor Cuomo announced: “We will continue to establish New York’s technology leadership in this important emerging market while balancing investments in other renewable resources and protecting the taxpayer. This approach will create jobs, expand solar power, and protect ratepayers—a win, win, win” (NYSERDA, 2012).

Since 2012, when Cuomo launched NY-Sun, through June 2014, a total of 316 MW of solar PV have been installed or are currently under contract. Approximately 116,000 tons of greenhouse gas emissions have been (and will be) avoided with the installation of these projects, a value equivalent to removing 23,000 cars from the road (NYS DEC, 2014). In anticipation of the solar growth sparked by this initiative, the New York State Public Service Commission approved a decision to triple the state's net metering cap, from 1 percent of peak load up to 3 percent (Prah, 2014). This means that utilities are required to offer net metering benefits for three times as much solar power produced by their customers. Additionally, in an attempt to solidify a 10 year extension of the NY-Sun program into law, both the New York State Assembly and Senate passed a version of the New York Solar Bill in 2013. However, consensus was not reached before the 2013 legislative session ended, and the bill was not enacted and signed into law (NY Solar, 2013).

Still, in April 2014 Cuomo further established his commitment to solar with \$1 billion in funding to continue the NY-Sun solar program. This program aims to increase solar power tenfold in New York by 2023 and transform the solar industry in New York to a sustainable, subsidy-free sector. The NY-Sun Solar PV Incentive Program offers reduced installation costs for systems up to 25 kW for residential customers and up to 200 kW for commercial customers (NYSERDA, 2014). Cuomo also announced other programs to encourage clean energy, like K-Solar, which will use schools as demonstration sites to increase solar energy projects, and the NY Prize competition, which will offer \$40 million to boost micro grid development to protect electrical grid disruption (Burgess, 2014).

New York State also uses a series of financial incentives to encourage renewable energy deployment. Common financial tools across states in the U.S. are public benefit funds (PBFs), or pools of public resources used to invest in clean energy supplies and programs. Public benefit funds are created by enacting a small fee, typically called a systems benefit charge (SBC), on customers' electricity bills. The New York Systems Benefit Charge (NYSBC) was one of the first of its kind established in 1996 by the New York State Public Service Commission. The most recent extension of the program in 2011, through 2016, set total funding for the five-year period at \$469 million (NYS PCS, 2014). The portfolio of programs is designed to increase energy innovation through scientific research, market analysis, technology development, and clean energy technology adoption, as well as more rigorous standards in codes, and promotion of a clean energy economy through business and market development. The program also incorporates other standards into its overall design, such as the state renewable portfolio standard (RPS), which requires utilities to provide a certain amount of power from renewable sources.

In addition, as part of NY-Sun, in December 2013, the New York Public Service Commission approved funding for a state green bank, to come from clean energy ratepayer funds, combined with funds from allowances from the regional cap and trade mechanism, the Regional Greenhouse Gas Initiative, for initial funding of \$210 million (NYSERDA, 2014). State green banks are a relatively new financial tool for sparking clean energy investment. Green banks use public debt to leverage private sector investment and bring elements of predictability and aggregation that reduce overall pricing, thereby eliminating a significant market barrier that has long slowed the development of new clean technology (Hendricks and Bovarnick, 2014). Green banks can help overcome market barriers such as lack of capital markets and federal policy uncertainty.

Innovative Local Policies: Shared Community Solar

One method to address some of the challenges with local solar energy use is a community solar model. Community/shared solar is defined as a solar PV project with multiple owners that live nearby and share

the cost and benefits of that ownership (Farrell, 2010, 2). “There are a lot of Americans who would love to get their energy from solar, but can't. They live in apartments and condos and don't own their rooftop. Or they do own a home or business, but really like the old oak tree that shades their roof. The National Renewable Energy Laboratory (NREL) estimated that 75 percent of American residential buildings have physical restrictions to going solar” (Masterjohn, 2012). Renters, people with shaded roofs, or buildings with roofs that are incompatible with solar installation are unable to overcome the technical and financial hurdles that would allow them to utilize renewable energy.

Community shared solar allows for expanded participation in the solar energy market. Residents and business owners can sign up to contribute to a local solar project, in exchange for some kind of compensation or credit on their utility bill. The solar panel does not have to be physically located on a user's property and it allows for more equitable access to clean energy. Shared projects are built within the community so all the environmental, economic, and public health benefits stay local (Masterjohn, 2012). There are several different ways these types of projects can be operationalized. For example:

- Utilities can provide customers with the option to purchase solar energy from a shared facility, often in exchange for a credit on their bills.
- Individuals can join in a business enterprise to develop a solar project, in a for-profit entity.
- Individuals can contribute to an installation owned by a non-profit, such as a school, church, or community building (SEIA b, 2014; Sunshot Initiative, 2012).

Different models have taken shape because each jurisdiction has its own regulatory and legal framework; each state has its own laws and regulatory environment, and each utility company has its own interests. Shared community solar systems have grown in recent years around the country, with at least 52 projects in 17 states, and at least 10 states encouraging them through targeted policies and programs (Cardwell, 2014). States that currently have laws to encourage shared solar include California, Colorado, Delaware, Maine, Massachusetts, Rhode Island, Vermont and Washington (SEIA b, 2014).

However, shared solar programs can be challenging to implement because most existing policies have been designed to support on-site generation or large-scale development. The federal solar investment tax credit also does not apply to shared solar projects; it only applies to photovoltaic systems installed on a home that a taxpayer owns (US DOE, 2010, 4). Because of this, many shared solar policies don't offer affordable options that cost the same or less than individual ownership. “Every community solar project is faced with the challenges of raising capital and accessing federal and state incentives for solar” (Farrell, 2010, 22). Furthermore, future community solar policies must address difficult securities regulations, the debate over ground-mounted versus rooftop solar, and how to determine the most effective ownership share model - individual, collective, or third-party (Farrell, 2010, 1). Community solar can also be hindered by net metering laws. Net metering makes it difficult to easily share the electricity credits with each of the owners or participants (Farrell, 2010, 3). An alternative would be to allow a group of meters to come together under a single project. A number of states have enacted a *virtual* net metering policy, where multiple homeowners/customers can participate in the same metering system and share the output from a single facility that is not actually connected to their property/meter (Hois, 2014).

The solar installation by the Clean Energy Collective in Colorado is the first known community-owned solar garden. The Clean Energy Collective developed a 78-kilowatt solar array on a purchase of 20 shares by local community members, in a special purpose entity model, which essentially combines the on-bill credits of a utility model with the tax benefits of individually owned solar projects (Sunshot Initiative, 2012, 22). One factor that enabled projects like this one is Colorado's Community Solar Gardens Act,

passed in June 2010, which offers subscribers of a community solar garden the same benefits as those who install panels on their roofs, including access to rebates and tax incentives (Snider, 2010). Customers can buy a 1-kilowatt share for \$3,700, while the cost of a residential rooftop array runs between \$20,000 and \$30,000 (Jaffe, 2013). Colorado also allows for community net metering, which means a group of investors can share the output from the solar array (Farrell, 2010, 3).

While Colorado is a leader in supporting community-based solar, New York State has also recently started to consider legislation around community/shared solar. New York Assembly Bill A09931, also known as the Shared Clean Energy Bill, was passed by the Assembly's energy committee in June 2014; a similar bill was also introduced in the Senate (S.7727) (Thill, 2014). If passed, these bills would amend state law to allow for the interconnection and operation of shared solar and wind facilities, which would only be authorized to sell to subscribers. This would allow a new community of renters, homes, schools, and businesses- those who don't have rooftops suitable for solar panels- to utilize solar energy. The bills would also allow energy consumers to subscribe to local renewable energy projects elsewhere in the community and receive a utility bill credit for their portion of the energy produced (Business Wire, 2014). The bill advanced from the energy committee to the Assembly Ways and Means Committee without any outright opposition and with broad support from environmental groups such as the Solar Energy Industries Association and the Natural Resources Defense Council. However, the 2014 legislative session ended without either version being passed.

The Future of Solar

Solar energy and other renewable energy sources are becoming cheaper and more efficient than traditional sources of energy, yet there are a number of issues in the U.S. that make it difficult to create long-lasting, stable and effective policies. Federal policies generally focus on the short-term, with loans and temporary subsidies, although there are some examples of long-term investments through research and development funding. States seek to develop policies and regulations that are flexible enough to last in an uncertain federal market. One impending challenge lies in the solar investment tax credit that is set to expire in 2016. This approaching date creates uncertainty for investors, while owners question the financial viability of installing solar panels. The impact of this expiration likely depends on the specific market in each state. Beyond issues with state policy, local jurisdictions have problems implementing initiatives such as community solar projects amidst complicated state and federal regulations.

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