

The Transition to Renewable Energy: Solar in Vermont

First discovered in 1952, Solar Photovoltaic (Solar PV) has a wide variety of benefits, including energy independence, job creation, and the ability to mitigate the impacts of climate change ([Solar, 2014](#)). Solar PV is on the rise both across the nation and in Vermont ([Solar, 2014](#)). Solar PV is Vermont's fastest growing form of renewable energy; between 2011 and 2016, Vermont installed 59.2 megawatts of commercial-scale solar PV capacity, with over half of the megawatts installed in 2016 alone ([Vermont: State Profile and Energy Estimates, n.d.](#)). In total, solar PV provides just over 10% of Vermont's electricity, and nearly 40,000 homes are powered by solar in the state. Furthermore, there are over 1,500 jobs and counting in the solar industry in Vermont ([Vermont Solar, n.d.](#)). This demonstrates the role that solar PV has in Vermont and the impact it has on communities throughout the state.

As a form of renewable energy, solar PV is an indicator of a community's sustainability. Sustainability is assessed through the complex interconnections between society, economy, and the environment. Solar PV is a clean, renewable energy that allows homeowners, business owners, and other local residents to rely on a stable form of energy production ([Hosenuzzaman et al., 2015](#)). By allowing communities to shift away from centralized fossil fuel systems, often prone to disruption and failure, local solar infrastructure creates energy independence and security ([Van Hoesen and Letendre, 2010](#)). Importantly, the numerous benefits from solar PV are not exclusive to those of a higher socio-economic status; social equity and accessibility can be incorporated into community solar PV projects ([Franklin, 2017](#)). Solar PV is secure, clean, renewable, and accessible, all of which are necessary components of resilient communities.

Within Vermont, widespread adoption of solar PV is an important pathway to reaching the statewide renewable energy goals. Adopted in order to reduce carbon emissions and mitigate the effects of climate change, in 2011 (and updated in 2016), the Vermont Department of Public Service produced a [Comprehensive Energy Plan](#) (CEP), calling for 90% of the state's energy to be from renewable resources by 2050 ([Comprehensive Energy Plan, 2016](#)). Renewables are meant to increase by 4% every year after 2017, so it is imperative that the state continue to incentivize communities and residences to make the switch to solar (["State Renewable Energy Goals"](#)). In addition to meeting the goals set out in the CEP, Vermont has a strong economic incentive to increase energy independence. Vermont spends much of its \$2 billion energy bill on

out-of-state expenditures, when that money could go back into the Vermont economy ([Forward, 2017](#)).

Recognizing the enormous benefits of adopting solar PV in Vermont, several stakeholders across the state are involved in the transition to 90% renewable energy. These stakeholders include utilities, government agencies, solar installation companies, Vermont residents, and low-income communities. When trying to increase solar PV in the state, one must consider several equity implications in addition to balancing competing interests and goals. Furthermore, because there are several stakeholders at play, responsibility for the improvement of solar PV is divided. The state government, the community members, and both the for-profit and nonprofit organizations have a role to play in its improvement.

Within the Vermont state government, there are several agencies involved with solar policy. The [Public Utility Commission \(PUC\)](#) is the governing body that regulates electricity rates and utility services. The PUC regulates siting and infrastructure for electric facilities. In Vermont, solar PV siting requires a certificate of public good (CPG) issued by the PUC. To obtain a CPG, the PUC will consider environmental impacts, need, reliability, economic benefit, and what would benefit the public interest. Where environmental impacts may be present, the [Vermont Agency of Natural Resources \(ANR\)](#) will assess whether additional permits, such as Stormwater permits and Wetland permits, will be necessary. The [Vermont Department of Public Service \(PSD\)](#) is a governmental agency that represents the public interest in energy concerns. The PSD has a wealth of publications online regarding PV solar, including the “[Vermont's Guide to Residential Solar \(2016\)](#).” The Vermont State Legislature, in combination with these agencies, works to create and enforce legislation and policies regarding solar PV.

Additionally, Vermont has several organizations who work to offer incentives and programs to aid the adoption of renewables. These include the [Vermont Energy Investment Corporation](#), [Renewable Energy Vermont](#), and [Efficiency Vermont](#). There are also [several installation companies](#), such as SunCommon, Green Earth Energy, Green Mountain Community Solar, and many more, throughout the State who create green jobs and promote the adoption of solar PV. Going above and beyond, solar installation companies, including SunCommon and Green Mountain Community Solar, have community solar programs geared towards making solar PV energy more affordable and accessible ([Green Mountain Community Solar, n.d.](#) ; [Vermont Community Solar, n.d.](#)). By addressing equity issues associated with solar PV,

installers have the ability to create innovative solutions and greatly expand the prevalence of solar in the state.

Perhaps most importantly, residents and communities who adopt solar PV technology are stakeholders. Although they play a less direct role in agenda setting and action, it is the public demand for solar PV that shifts the market and allows for widespread adoption. Several resources exist for Vermont residents who are interested in solar PV, such as the guide published by the PSD. The Vermont Natural Resources Council in partnership with the Vermont League of Cities and Towns created an [“Energy Planning and Implementation Guidebook for Vermont Communities.”](#) published in 2011. These resources, among others, serve as ways to educate residents and communities about the benefits of solar PV and how to adopt it.

Solar PV, as an indicator of a community’s sustainability, is difficult to measure conclusively. There are several indicators that could be used to assess solar PV in Vermont; such an assessment would require both environmental and economic indicators. An economic indicator may include energy consumption per capita or megawatt-hours of renewable energy consumed per capita. The price of solar PV installation and amount of jobs created by the solar industry could also be a measurement of the quality of this dimension. These would be considered social assessments on the community.

As stated above, the [Vermont Comprehensive Energy Plan](#) calls for 90% of the state’s energy needs to be met by renewables by the year 2050. With a decrease in the cost of solar panels, accompanied by tools such as community solar, solar PV has the potential to meet a significant percentage of the state’s renewable energy generation ([Reichelstein, S., & Yorston, M., 2013](#)). Private installations, while vital to meeting the goal, are often more expensive. Furthermore, older homes are often not equipped to support rooftop solar PV panels. Community solar would be the most effective and affordable way to utilize solar PV so that everyone could receive its benefits.

Another way to gauge the growth of solar PV in Vermont is to assess the growth of sustainable education. Education surrounding solar PV and renewable energy increases our ability to furnish a society that can work within the earth’s finite resources. The solar process in Vermont can be challenging to navigate, and many communities are unaware of their energy options and the available community solar programs. Vermont can work to reach its goals under

the CEP, while also improving community sustainability, through the implementation and increased installation of solar PV.

While several indicator options exist, to measure the installation of solar PV in Vermont, and accurately dissect trends in renewable energy transitions for the Vermont CEP, a precise indicator would be the amount of megawatts (MW) of electricity in Vermont powered by solar PV. This data is highly usable and indicative of solar PV usage in Vermont. A number of national, state, and local entities are already utilizing this measurement. The [Solar Energy Industries Association](#) has measured solar usage historically in Vermont, and states across the country. The [state of Vermont](#) also keeps track of solar and other renewable energy usage to monitor progress towards the sustainability goal. This indicator can therefore be used to promote the increased installation of solar PV throughout the state of Vermont, and it offers simple and direct feedback on progress. Increasing solar PV usage can improve community sustainability and help in attaining the 90x2050 statewide energy goals. Fortunately, this is a trend that we are already seeing in Vermont.

Over the past decade, Vermont has seen a significant increase in the prevalence of solar energy. Currently, solar makes up a small but growing portion of electricity generated in the state. The Solar Energy Industries Association (SEIA) published a “Solar Spotlight” for Vermont, detailing both historical trends in solar installations and estimated future trends in solar installations. Prior to 2010, the SEIA had not recorded any solar installations in Vermont. Since 2011, Vermont has installed 212.5 MW of solar, with 22.7 MW installed in 2017. The SEIA projects an additional 221MW will be installed over the next 5 years ([Solar Energy Industries Association, 2018](#)). Notably, in 2022 SEIA predicts that 20 MW of residential solar alone will be installed ([Solar Energy Industries Association, 2018](#)). See Figure 1. As of 2018, there were over 38,000 homes in Vermont powered by solar ([Solar Energy Industries Association, 2018](#)). Overall, there is a general trend towards an increase in solar installations in Vermont.

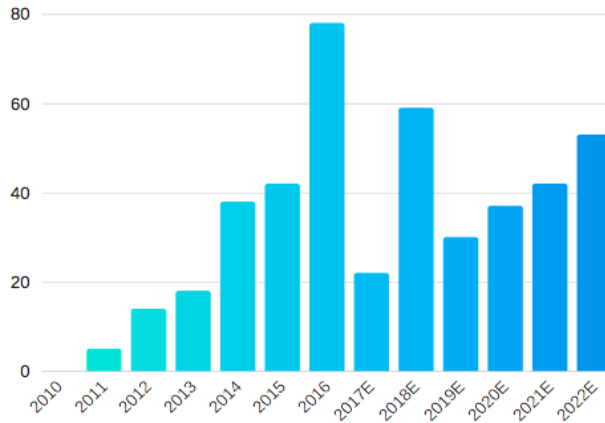


Figure 1. Vermont Annual Solar Installations (in MW)
 (Source: Solar Energy Industries Association, 1018)

Notably, in 2014, “all new electricity generating capacity added to Vermont’s grid... was solar-powered” ([SunCommon](#), n.d.). 2014 alone saw 38 MW of installed solar capacity, totaling 87 MW total installed solar in Vermont. These 87 MW have the ability to power 15,200 homes in the state ([SunCommon](#), n.d.). Despite this incredible feat, solar energy is still a tiny fraction of the total energy Vermont generates. SunCommon, a solar installation company in Vermont, published information on Vermont’s electricity generation. See Figure 2.

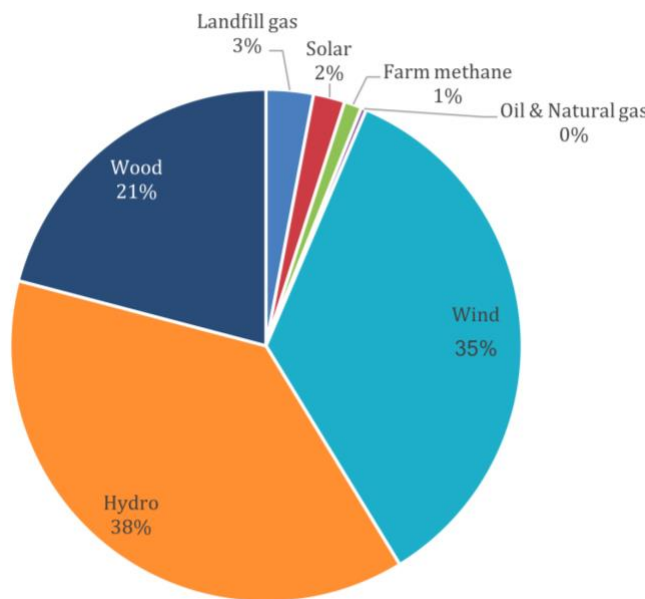


Figure 2. Vermont Electricity Generation (Source: SunCommon)

A summary report published in December of 2016 shows the increase in solar installations and generating capacity needed to reach the 90% renewable by 2050 goal (see Table 1). A sharp jump is required to meet the goal. However, falling costs of solar panels coupled with programs such as community-solar, demonstrate that the goal is lofty, but not unattainable; we are already on our way. Working to reach this goal and keeping track of MW installed are the installation companies and Vermont State Agencies. The Solar Siting Task Force, reporting to the Vermont State Legislature, completed a [report](#) in 2016 to review solar generation in the state. Looking at MW installed throughout the state, succinctly stated, “by all measures... solar is on the rise. All told, growth in the solar sector has resulted in approximately 200 MW either permitted or in the permitting process in Vermont” (Solar Siting Task Force Report, 2016).

Table 1. Energy and Electricity Consumption in Vermont

Total Energy		Electricity		Solar		
Total energy demand (TBtu)		Electricity demand (GWh)	Electricity share of total energy demand	Solar generation (GWh)	Share of electricity from solar	Installed capacity (MW)
2015*	116	5,700	17%	280	4.9%	225
2025	106	6,200	20%	1,300	20%	1,000
2050	69	8,800	44%	2,500	28%	2,000

Source: Reproduced from Vermont Solar Market Pathways, 2016.

Although positive trends are being seen throughout the state, when collecting data for solar photovoltaic projects, there are uncertainties to be aware of. Specifically, there is an inherent risk in trusting public data. Much of the solar data available does not meet specific conditions. According to the National Renewable Energy Laboratory, “The measurement of the photovoltaic (PV) performance with respect to reference conditions requires measuring the current versus voltage with respect to a given tabular reference spectrum, junction temperature, and total irradiance” ([Emery, 2009](#)). If these conditions are not met, the measurement will be

false. Modeled data, as opposed to on-site data, is used most often, however, this data is often inaccurate. Uncertainties in energy data can be reduced by on-site monitoring projects and data validation plans ([Emery, 2009](#)). Data validation ensures that data has undergone cleansing and is considered accurate. The reduction of uncertainties will increase the level of confidence in solar data.

Another concern with solar PV data is that there is little data recognizing the amount of homes or communities that contribute to the total watts produced. As of 2018, we know that there were 38,000 homes using solar, however, there is no data from previous years that indicates this value. Therefore, we do not know the rate of change over time. Much of the solar data available reports the amount of energy emissions, making it difficult to ascertain the number of homes using solar. Solar data in the state of Vermont should include both the amount of solar energy emissions in the state and the number of homes that have installed solar PV system, as this information is highly important when conducting a study on the development of solar energy.

Despite the uncertainties mentioned above, there is a demonstrated need for Vermont to increase solar generation. To accomplish this, Vermont has many incentives to encourage citizens to move towards a solar lifestyle. Vermont residents who invest in solar do not have to pay additional taxes on their system because of the [Renewable Energy Systems Sales Tax Exemption](#) (US Department of Energy). Community shared solar and net-metering are two additional incentives. Green Mountain Power is the most popular utility net metering program in Vermont, although the program is currently on hold. Lastly, the federal government will aid Vermont residents in investing in solar energy systems. Homeowners can minimize the cost of their solar energy systems by 30% with Investment Tax Credit. Vermont considerably encourages residents to invest in solar, and other states are encouraging this action as well.

[The Energy Development Improvement Act](#) was approved by the Vermont Senate in July of 2016. It was created to merge energy development and land-use planning. It encourages efficient use of energy by setting regional and municipal energy standards (Vermont General Assembly). Many states are passing laws that could influence states that have not yet considered the value of solar. Seventeen states passed laws that act as renewable energy incentives, many of which are similar to those implemented in Vermont. For instance, Arizona has tax credit and exemption incentive programs, while Idaho has tax deduction and loan programs ([Darcey, 2017](#)).

By providing examples of incentives to increase renewable energy adoption, these states serve as models for Vermont.

If Vermont sticks to its goal of increasing power generated by renewable energy by 4% every year, it will become a leader across the country in green energy and the drive towards a more stable climate. However, most of the renewable energy the state currently produces is hydroelectric, which has been shown to have a negative effect on lake health and cannot always be considered a renewable energy resource ([Daigneau, 2013](#) ; [Richard, 2008](#)). Moving forward, Vermont needs to further specify where this planned 4% increase will come from every year, and priority should be given to solar, a form of energy generation that is truly renewable and that can give energy independence back to communities and homeowners.

Community solar programs such as SunCommon CSA are currently on hold due to the new net-metering law. Moving forward, net-metering policies must be crafted that permit the expansion of solar PV and community-solar arrays. In order for this change to occur, a compromise must be found to balance the utilities and their need for profit, with the ability to increase widespread adoption of solar. Although challenging, research should be done on other community-solar programs implemented in states such as Connecticut and New Hampshire, to see if they could serve as models for Vermont. By making programs such as the CSA accessible and affordable, solar usage could be available for all Vermonters regardless of where they live in the state. To achieve this goal, stakeholders will have to work together and active engagement between the community, the PUC, installation companies, and the utilities will be required.

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