
Net Metering in Vermont

An Assessment of NEM 2.0 and Recommended Adjustments

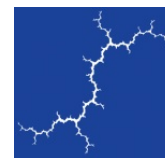
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EXECUTIVE SUMMARY

Over the past two decades, Vermont's net metering policy has supported the robust growth of distributed solar in the state, contributing to the economy and providing utility system, environmental, and economic benefits. However, the development of distributed solar has slowed significantly with the implementation of net energy metering (NEM) 2.0, which reduced the value of net metering credits. NEM 2.0 was intended to address concerns regarding customer rate impacts and to encourage better siting decisions. These are worthwhile objectives that deserve proper analysis and consideration. At the same time, other objectives—such as meeting the state's energy policy goals and economic development—should also be appropriately analyzed. Furthermore, expected changes in solar development costs should be considered, including higher panel prices, increasing interest rates, and potentially higher materials costs due to federal steel and aluminum tariffs.

This report seeks to shed light on how distributed solar relates to Vermont's energy policy objectives and mandates, as well as the contribution that solar makes to the state economy through clean energy jobs and tax revenues to cities and towns. Our analysis then turns to the question of cost-shifting and impacts that NEM policies are likely to have on customers without solar installations. And finally, we assess how different compensation rates affect customers' willingness to invest in distributed solar, which has implications for the ability of the state to meet its energy and climate targets. All of these impacts should be considered as a whole when contemplating modifications to net metering compensation rates.

Some of our key findings are:

- Distributed solar plays a key role in meeting state renewable energy goals.
 - Vermont's Renewable Energy Standard (RES) requires that distributed renewable generators, such as net metered solar, account for 10 percent of all electricity sales by 2032.
 - Vermont's Comprehensive Energy Plan (CEP) calls for a 5x to 8x increase in solar PV statewide. Further, because of contractual or limited siting opportunities facing other renewables, even more solar may be necessary to achieve Vermont's renewable energy goals.
 - Given the expected decline in utility-owned or -contracted solar and an expected 10 MW per year of Standard Offer solar, achieving Vermont's goals requires at least 20 MW of NEM PV deployment annually in the coming years.
- Distributed solar reduces many utility system costs (such as the cost of purchasing energy and capacity), while also providing environmental benefits to all Vermonters. We



estimate the annual societal benefit of the carbon, NO_x, and SO_x emissions reductions due to NEM 2.0 solar installed in 2017 to be more than \$1 million per year.

- Distributed solar PV brings considerable economic benefits to Vermont in the form of jobs and economic development, as well as tax revenues.
 - The job impacts resulting from NEM 2.0 installations in 2017 were over 300 job-years and an estimated \$133,800 in personal income tax paid on over \$6,688,000 in wages. This impact is above and beyond job impacts from NEM 1.0 installations.
 - We estimate that in 2017 the combined tax payments for all NEM systems in Green Mountain Power's territory alone were more than \$1,720,000.
- Cost-shifting due to NEM 2.0—i.e., the impacts on utility rates, exclusive of any broader environmental and economic impacts—averages only \$0.04 per month for the typical residential customer, averaged over the 25-year study period. Reducing cost shifting was one of the primary purposes of lowering NEM compensation to the NEM 2.0 levels, and this action has been effective.

As policymakers review Vermont's successful net metering program, it is critical to understand the full range of impacts that net metering has—not just on Vermont's electric system and ratepayers, but also on the state's overall objectives. For these reasons, Synapse recommends the following changes to the NEM 2.0 rates:

- The REC payment should be reduced from +/- \$0.03 per kWh to +/- \$0.0275 per kWh, and
- The siting adjustor for both Category I and well-sited Category II projects should be increased by a half-cent per kWh.

These changes in NEM 2.0 are recommended to provide the gentle guidance necessary for the appropriate annual construction of new net metered solar capacity necessary for Vermont to achieve its RES and CEP targets.

1. INTRODUCTION

1.1. The Evolution of Net Metering in Vermont

Vermont has a 20-year history of net metering, having passed 30 V.S.A. § 219a in 1998. That law called for customer-side renewable and combined heat and power (CHP) generation from small generators to



count 1:1 in offsetting energy delivered by the electric utility. After studying the value that customer-sited solar photovoltaic (PV) generation provides to the utility system in 2008, Green Mountain Power offered customers \$0.20 per kilowatt-hour (kWh) for generation, approximately six cents more than retail rate. The Vermont legislature viewed this program as a success and in 2011 created a policy wherein the total compensation for customer-sited solar generation would be \$0.20 per kWh for electric customers statewide. The legislature continued its interest in supporting customer-sited generation, amending the net metering law in 1999, 2002, 2008, 2011, 2013, and 2014 to allow for increasingly larger systems, more systems, group net metering, and to adjust payments for customer-contributed energy.

These early years of net energy metering (NEM) are referred to as “NEM 1.0.” In recent years, Vermont has shifted away from NEM 1.0 by reducing compensation for generation and incentivizing customer transfer of renewable energy credits (REC) directly to the utilities.

Implemented in 2017, Vermont NEM 2.0 included several changes intended to reduce the costs and pace of the net metering program. Solar participants now must pay a one-time fee to be a NEM customer, and monthly charges such as customer service, energy efficiency, and electric assistance have been made non-bypassable. Most significantly, compensation for generation was reduced for all sizes of net metered systems—through both the statewide blended rate and siting adjustors—to reflect a reduction in utility avoided costs and the decline in solar photovoltaic (PV) installation costs. To further limit the pace and overall total capacity of net metering generation, no customer’s cumulative utility accounts, regardless of the site usage or generation location, may be credited more than 500 kW of net metered generation, a policy that disproportionately affects larger schools, towns, and businesses.

Under NEM 2.0, distributed solar PV deployment in Vermont has declined considerably as compared to NEM 1.0. Although deployment is reduced due to a misalignment in total compensation, the REC portion of the compensation appears to be well-aligned, as Vermont utilities are purchasing nearly all of the RECs generated by NEM 2.0 installations. These two critical factors—overall NEM deployment and utility REC acquisition—are the two critical outcomes of the NEM 2.0 program that should be at the forefront when considering changes to the NEM program.

1.2. Broader Policy Goals

Importantly, NEM 2.0 was designed within the context of eight renewable energy goals codified by the Vermont legislature:

1. Balance costs and benefits
2. Support the development of renewable energy and economic development
3. Provide price stability
4. Develop markets for renewable projects (and energy efficiency projects)
5. Promote water and air quality



6. Reduce climate change pollution and negative economic exposure to federal regulations
7. Support distributed generation
8. Promote diverse technologies¹

Additionally, NEM 2.0 was designed to influence a project's land-use circumstance by increasing or decreasing the value of generation credits depending on the location, such as greenfield, brownfield, or superfund. Because siting is such an important policy directive in Vermont, the application process was also revised to facilitate increased public participation in Public Utility Commission (PUC) proceedings. Broader policy goals including promoting renewables, reducing pollution, economic development, price stability, responsible site-appropriate development, and supporting distributed generation and diverse technologies are all important considerations in the development of both the rules and the rates under NEM.

1.3. Assessing Cost-Shifting

The design of electricity rates is an act of balancing numerous competing objectives. Rates should be designed to provide sufficient revenues to the utility, equitably recover costs, and provide efficient price signals, all while being simple enough to be understood by the general public. No rate structure perfectly accomplishes all of these objectives, and thus no rate will perfectly reflect the cost of serving every customer. For example, rates generally fail to account for geographic diversity—despite a rural customer at the end of a circuit typically requiring much greater utility investment than a home located in the town center. Other deviations from a strict cost-causation standard are undertaken for the sake of accomplishing public policy goals, such as the provision of discounts to low-income customers. It is within this context that rates for net metered customers should also be considered.

As part of Vermont's stated objective of using distributed renewable generation to help meet its renewable energy requirements, it is important to understand the impacts of such policies on non-NEM customers. The potential for cost-shifting from net metered to non-net metered customers is an important issue that should be analyzed as concretely and comprehensively as possible. Cost-shifting from net metered customers to non-net metered customers can occur in the form of rate impacts, which can result in higher bills for non-solar customers. However, when viewed from a societal impact perspective, net metered customers may deliver more value than reflected in their monetary compensation. Rates increase or decrease to reflect changes in electricity sales levels, changes in costs,

¹ 30 V.S.A. § 8001



or both. A comprehensive, long-term rate impact analysis will account for both of these effects, thereby providing the necessary information to help understand this critical issue.²

A rate impact analysis should be built upon two primary inputs:

1. Changes in utility revenue requirements due to net metering over a study period of approximately 25 years
2. Changes in utility sales resulting from net metering

Analysis of both long-term and short-term rate impacts is important because the avoided costs associated with net metering may change over time. For example, in the near term, a utility may have sufficient capacity to serve load and therefore the avoided capacity costs attributable to additional net metered generation may be low. However, additional capacity might be required several years in the future. If net metering can help to avoid such capacity additions, the benefits associated with net metering could be substantial. A short-term analysis of the costs and benefits of net metering would miss these benefits that occur in the later years. Thus, a short-term rate impact analysis will not fully capture the impacts of net metering and should not be performed without also evaluating long-term rate impacts.

1.4. Net Metering Compensation and Customer Adoption

Net metered generation constitutes a small fraction of electricity sales in Vermont. For illustration, we estimate that Green Mountain Power customers generate less than 4 percent of the utility's electricity sales.³ Increasing this amount to meet the state's renewable energy objectives will require continued adoption by customers. However, early adopters have already adopted distributed solar; new participants in net metering are more likely to require a positive financial analysis. A useful metric for indicating the extent to which different policies will affect the adoption, or lack of adoption, of distributed solar resources by customers is the simple payback period. Policies that lead to very short customer payback periods will likely produce rapid growth in these resources, while policies that lead to very long customer payback periods will result in little growth.

A decline in compensation rates leading to a longer payback period can have extreme consequences. If rates are even slightly too low, uptake drops rapidly, with significant economic consequences related to both lost jobs and small business bankruptcies. Getting the rates just right is challenging, as installation

² Woolf, T., Whited, M., Knight, P., Vitolo, T., & Takahashi, K. 2016. *Show Me the Numbers: A Framework for Balanced Distributed Solar Policies*. Cambridge, MA: Synapse Energy Economics, available at http://www.synapse-energy.com/sites/default/files/Show-Me-the-Numbers-16-058_0.pdf.

³ Calculated based on NEM generation estimates (using NEM 2.0 installations through December 2017, as reported by GMP in its "Comments on the Department of Public Service RE: Notice of Proceedings and Scheduling Order," February 1, 2018, and NEM 1.0 installations reported by Robert Dostis of GMP in testimony before the Senate Finance Committee on February 15, 2018), NREL's PV Watts calculator, and GMP sales as reported in EIA Form 861.



costs are currently facing both upward pressures due to the sunset of the federal investment tax credit (ITC) and the recently imposed tariffs on solar panels, and downward pressures associated with a maturing industry. The consequences of making aggressive adjustments are likely to be severe and manifest quickly.

1.5. Factors When Considering Net Metering Modifications

Net metering as public policy has a 20-year history in Vermont, and it has been an effective tool to drive solar installations on residential rooftops, commercial sites, and brownfields. Vermont public policy includes the promotion of renewable energy, economic development, greenfield preservation, and price stability, all at an appropriate balance of costs and benefits to participants and non-participants alike.

Net metering is also an important component of the broader set of policies driving renewable energy development in Vermont, working towards a Vermont Comprehensive Energy Plan goal of meeting 90 percent of Vermont's energy needs through renewable sources by 2050.⁴ Ongoing modifications of the NEM 2.0 rates are important to ensure that distributed solar uptake continues at an appropriate pace, balanced with consideration for siting and cost-shifting. Importantly, even moderate changes to the program design or payment schedule can result in dramatic changes in solar PV deployment. Changes should be thoughtful and gradual to avoid the costly boom-bust cycles experienced by other jurisdictions.

2. OVERVIEW OF DISTRIBUTED SOLAR IN VERMONT

There are various statistics regarding the quantity of solar PV in Vermont, depending on the classification of the resource. For example, at the wholesale level, solar PV is classified based on different levels of market participation (i.e., capacity resources that bid into the forward capacity market, those that participate as “energy only resources,”⁵ and those that are accounted for only as load-modifying behind-the-meter resources). The quantity of solar PV also varies by project completion status (proposed, approved, constructed, or operating), and for behind-the-meter resources, ratemaking status (NEM 1.0 or NEM 2.0). This report focuses on solar PV resources relevant to 18-0086-INV: net metering resources sized 500 kW or smaller.

There are broad public policy considerations associated with the size of net metering projects: Category I (under 15 kW), Category II (15 kW–150 kW), and Category III (150 kW–500 kW). Recognizing that there

⁴ Vermont Department of Public Service (DPS). 2016. *2016 Comprehensive Energy Plan*, page 5.

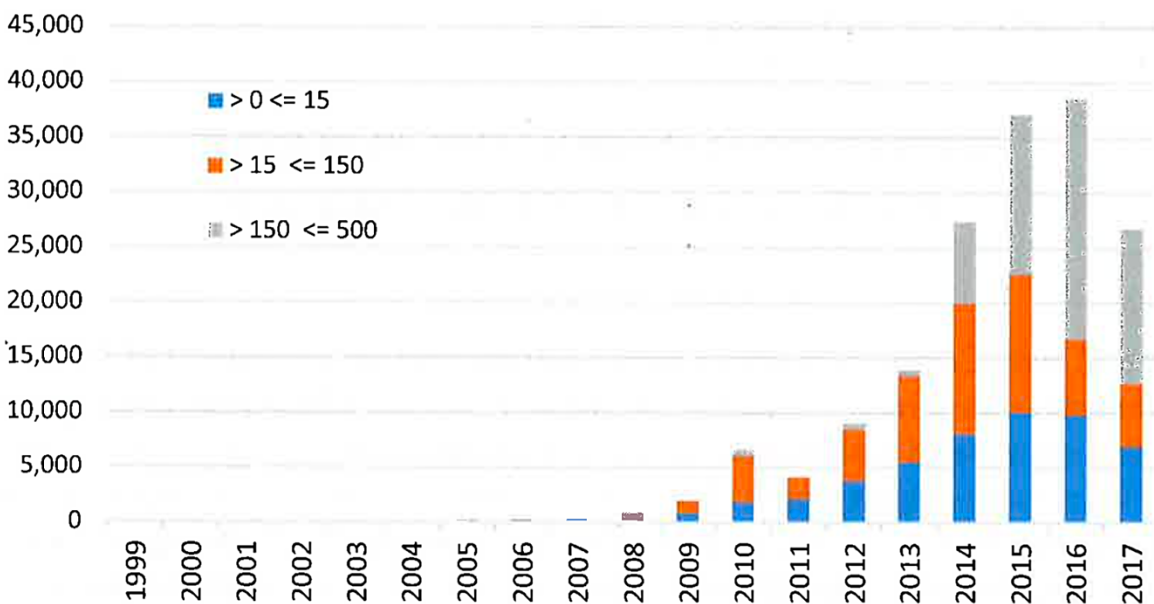
⁵ Energy Only Resources (EOR) are much more commonly found in Southern New England than in Vermont.



is an interest in maintaining an ongoing installation effort for all three categories, it's worth noting that the per-kWh compensation rates for the Category III net metering systems are several cents lower than the Category I systems; the utility therefore acquires the energy, capacity, and RECs⁶ associated with Category III projects at lower cost than those associated with smaller projects.

The growth of net metered solar generating capacity was nearly imperceptible before 2008 by today's capacity standards. From 2009 until 2014, Vermont saw exponential growth. Due to a variety of economic and regulatory factors including the transition to NEM 2.0, the growth has stagnated and begun to decline since 2015. In fact, all three NEM 2.0 size categories show a decline in the capacity of permits offered from 2016 to 2017. These trends can be seen in Figure 1 below. Because the chart includes both NEM 1.0 and 2.0 combined, it does not make clear that the majority of NEM installed in 2017 was under the NEM 1.0 regime; only 12.9 MW of NEM 2.0 was installed in 2017.⁷

Figure 1. Permitted Solar Net Metered Capacity (kW) by Size Category, NEM 1.0 and 2.0 Combined, 1999–2017



Source: Vermont Department of Public Service Supplemental Information Request by the Department of Public Service, February 8, 2018. Case No. 18-0086-INV.

⁶ Under NEM 2.0, the utility compensates the customer \$0.03/kWh for each REC generated in the first ten years; the customer must deliver all RECs generated after the 10th year to the utility indefinitely, for no additional compensation.

⁷ Vermont DPS, "Comments on the Department of Public Service RE: Notice of Proceedings and Scheduling Order," March 1, 2018. Page 17.



Grid reliability concerns are frequently raised in conjunction with distributed generation adoption. Care must be taken to ensure that each installation maintains or enhances safety, stability, and reliability on site, on the local distribution circuit, at the substation, and along the transmission system. Fortunately, regulations promulgated by ISO New England, the State of Vermont, and the individual utilities ensure that a system may not be interconnected unless the utility has studied and ensured that safety and reliability will be maintained.

GMP have expressed concern about the total nameplate capacity of solar PV expressed as a fraction of system peak.⁸ This discussion is misplaced because utility engineers already ensure safety and reliability; the appropriate safeguards for preserving safety and reliability are already in place at the project level. Project-level assessments will always be far more applicable to the situation than a system-wide number such as total nameplate capacity. Project-level safeguards obviate system-wide solar percentage of peak concerns; it is inappropriate to prevent an individual project from moving forward when that project doesn't threaten safety or reliability, regardless of the capacity of solar PV elsewhere on the electric system.

For Vermont to reach its energy policy goals, the 2016 CEP clearly states that there is “a need for increases in supply, particularly in renewable supply, in Vermont’s portfolio.”⁹ By 2050, 9 terawatt-hours of renewable energy will be required each year. The CEP outlines three possible scenarios for meeting this requirement. In Scenarios A and B, 2,250 MW of solar PV are envisioned; in Scenario C the quantity is 1,500 MW.¹⁰ As of the date of publication of the CEP, there were 4 MW of utility-owned solar PV, 7.5 MW of solar PV power purchase agreements, 59 MW of solar PV standard offer generators, and 85 MW of net metered solar PV, for a total of approximately 160 MW.¹¹ Since then, an estimated 139 MW of net metered, standard offer, and utility-owned or PPA solar has been installed.¹² This brings the total quantity of solar in Vermont to just under 300 MW—between one-fifth and one-eighth of its long-term solar capacity goals. To achieve those goals in a cost-effective manner, Vermont should plan and implement the distribution system upgrades necessary to accommodate additional solar, and Vermont should avoid the boom-bust cycles often found when solar rules and regulations are altered suddenly or dramatically.

⁸ Green Mountain Power “Comments on the Department of Public Service RE: Notice of Proceedings and Scheduling Order,” February 1, 2018. Page 4.

⁹ Vermont DPS. *2016 Comprehensive Energy Plan*, page 238.

¹⁰ *Ibid*, page 239.

¹¹ *Ibid*, pages 192–194.

¹² Vermont DPS, “Comments on the Department of Public Service RE: Notice of Proceedings and Scheduling Order,” March 1, 2018. Page 15.



3. BENEFITS OF DISTRIBUTED SOLAR TO VERMONT

Distributed solar can offer the utility system and society a host of benefits, ranging from avoided energy and capacity costs to reduced environmental impacts. At the same time, distributed solar may impose administration and integration costs on the system. The costs and benefits are often location-specific and may vary greatly over time, due to changes in penetration levels and changes in avoided costs. For these reasons, the net benefits of distributed solar are notoriously difficult to calculate.

Value of solar studies are numerous, each customized to the unique circumstances of the jurisdiction. Such studies take into account many factors, including wholesale market status, renewable portfolio standards, system load profile, avoided emissions allowance costs, details related to the transmission and distribution systems, changes in loss of load probability, reduction in fuel price risk, and possibility of avoided future capital costs. Depending on the purpose of the study, wider societal benefits may be included as well. Examples include environmental externalities (e.g., the social cost of carbon), tax revenue, and employment benefits. This report does not seek to perform a bottom-up value of solar study. Instead, recognizing Vermont's approach of balancing utility system costs and benefits with broader public policy objectives, this report considers two broad categories of benefits:

- 1) The utility system avoided costs for demand-side resources, as established by the Vermont Public Utility Commission most recently in October 2017 in Docket EEU-2015-04, and
- 2) Additional benefits not included in the quantified avoided costs but with key policy implications. These benefits include renewable energy compliance and achievement of comprehensive energy plan goals; pollution reduction benefits; and economic benefits.

Below we briefly describe these benefits and how they should be considered in determining net metering compensation rates.

3.1. Avoided Costs for Demand-Side Resources

The Vermont Public Utility Commission has long required the Vermont Energy Efficiency Utilities to conduct cost-effectiveness analyses of energy efficiency using estimates of avoided costs, including avoided energy, capacity, and externalities (carbon dioxide emissions). The avoided costs are based on periodic *Avoided Energy Supply Costs in New England* reports, as modified and updated by the Vermont Department of Public Service and approved by the Commission.¹³

¹³ We note that these avoided costs reflect a counterfactual future without energy efficiency, and are thus expected to be higher than the costs seen in the region under actual delivered energy efficiency. Nonetheless, they are indicative.

In October 2017, the Commission approved the most recent avoided cost update in *Order Re: EEU Avoided Costs, Externality Adjustments, and Other Screening Components for 2017–2018 Time Period*, in docket EEU-2015-04. These values were used as the basis for the cost-shifting analysis discussed later in this report and are summarized in the table below.

Table 1. Avoided energy, capacity, and transmission/distribution costs for Vermont (2017–2018)

Year	Avoided Unit Cost of Electric Energy				Avoided Capacity \$/kW-yr	Avoided Transmission & Distribution \$/kW (2012\$)
	Winter Peak (\$/kWh)	Winter Off-Peak (\$/kWh)	Summer Peak (\$/kWh)	Summer Off-Peak (\$/kWh)		
2017	0.05	0.04	0.03	0.02	130.72	155.00
2018	0.05	0.04	0.03	0.02	151.90	152.00
2019	0.05	0.04	0.04	0.03	101.88	152.00
2020	0.05	0.05	0.05	0.03	104.21	152.00
2021	0.06	0.05	0.05	0.04	111.34	152.00
2022	0.06	0.05	0.05	0.04	104.92	151.00
2023	0.07	0.06	0.05	0.04	98.58	150.00
2024	0.07	0.06	0.06	0.05	102.67	149.00
2025	0.07	0.06	0.06	0.05	113.16	149.00
2026	0.07	0.06	0.06	0.05	123.87	148.00
2027	0.07	0.06	0.06	0.05	134.19	147.00
2028	0.07	0.06	0.07	0.05	144.76	146.00
2029	0.07	0.07	0.07	0.06	156.11	145.00
2030	0.08	0.07	0.07	0.06	171.45	144.00
2031	0.08	0.07	0.08	0.06	178.28	143.00
2032	0.08	0.07	0.08	0.06	178.28	142.00
2033	0.08	0.07	0.09	0.06	178.28	141.00
2034	0.08	0.07	0.09	0.06	178.28	140.00
2035	0.08	0.08	0.09	0.07	178.28	139.00
2036	0.08	0.08	0.10	0.07	178.28	138.00
2037	0.08	0.08	0.10	0.07	178.28	137.00
2038	0.09	0.08	0.11	0.07	178.28	136.00
2039	0.09	0.08	0.11	0.07	178.28	135.00
2040	0.09	0.08	0.11	0.08	178.28	133.00

Source: Vermont Public Utility Commission, Order filed October 20, 2017, Docket EEU-2015-04.



3.2. Renewable Energy Standard Compliance

Vermont's Renewable Energy Standard (RES) was enacted upon the signing of H.B. 40 into law in June 2015,¹⁴ and implemented by the Commission in June 2016.¹⁵ The requirements include that utilities procure an increasing amount of energy from renewable resources, growing to 75 percent by 2032. Further, an increasing fraction must come from new, distributed renewable generators such as net metered solar PV, increasing to 10 percent of all sales by 2032. 25-30 MW of distributed solar PV generation is required each year to meet Tier 2.¹⁶ Because 10 MW is allocated for Standard Offer and because utility-owned or -contracted projects are expected to slow considerably, NEM rates should be designed to foster 15-20 MW of new NEM PV development per year.¹⁷

In practice, however, the near term annual capacity of new net metered solar PV must exceed the lower end of the 15-20 MW to ensure compliance, for three reasons. First, Vermont utilities are not procuring the RECs associated with all new solar installations. The RECs produced by many of the installations that came online under NEM 1.0 are being sold to third parties, often out of state, and therefore are not contributing to Vermont RES compliance. Second, because the ideal sites for distributed solar are pursued first, the average capacity factor for new rooftop installations will gradually decline, requiring slightly more MW to generate the same number of RECs. Third, as Vermont residents and small businesses continue to participate in net metering solar programs, more and more projects will be rejected by transmission and distribution engineers because those individual projects cannot be installed until grid infrastructure is upgraded; this will result in an increasing fraction of projects delayed in the more distant future. For all of these reasons, Vermont must target a pace of installations in excess of 20 MW per year in the near term if it is to comply with its own policy objectives.

3.3. Comprehensive Energy Plan

The long-term energy vision contained in Vermont's 2016 CEP requires the state's renewable energy to more than double, from approximately 4 TWh of renewable energy in 2018 to 9 TWh of by 2050.¹⁸ All

¹⁴ Vermont H.B. 40, Bill as Passed the House and Senate, 2015. Available at:

<https://legislature.vermont.gov/assets/Documents/2016/Docs/BILLS/H-0040/H-0040%20As%20Passed%20by%20Both%20House%20and%20Senate%20Official.pdf>.

¹⁵ Vermont Public Utility Commission, "Order Implementing the Renewable Energy Standard," June 28, 2016, Docket No. 8550. Available at: http://puc.vermont.gov/sites/psbnew/files/doc_library/8550-final-order.pdf.

¹⁶ Vermont DPS, "Comments on the Department of Public Service RE: Notice of Proceedings and Scheduling Order," March 1, 2018. Page 15.

¹⁷ Vermont DPS, "Comments on the Department of Public Service RE: Notice of Proceedings and Scheduling Order," March 1, 2018. Page 16.

¹⁸ Vermont DPS, *2016 Comprehensive Energy Plan*, Exhibit 11-3, page 240.



three scenarios in the CEP include substantial increases in solar, wind, and large hydro, and a smaller increase in biomass. Large hydro requires international contracting, and wind installations tend to be site limited. Solar, on the other hand, has tremendous siting potential under existing siting limitations. Not only does the CEP call for a 5x to 8x increase in solar PV statewide, but because solar does not face the contractual or limited siting opportunities facing large hydro and wind, it is possible that even more solar than envisioned in the 2016 CEP will be necessary to achieve Vermont’s comprehensive renewable energy goals.

The 2016 CEP notes that “net metering provides an appropriate tool to develop a significant portion of” Tier 2 generation, further justifying a near term target of at least 20 MW of new NEM PV each year in the near term.¹⁹

3.4. Pollution Reduction Benefits

Only a fraction of the detrimental externalities associated with air pollutants emitted by electric generating units are monetized. With respect to carbon pollution, all but the smallest carbon emitting generators in New England purchase Regional Greenhouse Gas Initiative (RGGI) allowances for each ton of carbon emitted, valued at approximately \$0.0156/kWh of solar generation.²⁰ Additionally, while the New England states are no longer required by EPA to operate SO_x and NO_x clean air markets, there remains a chance that more stringent air regulations requiring the trading of SO_x or NO_x allowances will be re-implemented.

In addition to the internalized per-kWh avoided costs associated with solar PV energy production, there are societal costs of carbon, SO_x, and NO_x pollution in excess of the internalized costs.²¹ The net social costs represent the total cost that the pollutants impose on society minus the (smaller) per-unit fees the generators must pay. Acadia’s 2015 study of distributed solar PV in Vermont details these costs, as summarized in the table below.

¹⁹ Vermont DPS, 2016 Comprehensive Energy Plan, page 257.

²⁰ Acadia Center. 2015. “Value of Distributed Generation: Solar PV in Vermont.” Appendix A. Available at: http://acadiacenter.org/wp-content/uploads/2015/07/AcadiaCenter_GridVOS_Vermont_FINAL_2015_0730.pdf.

²¹ U.S. Environmental Protection Agency. 2014. *Regulatory Impact Analysis for the Proposed Carbon Pollution Guidelines for Existing Power Plants and Emission Standards for Modified and Reconstructed Power Plants*. Available at: <http://www2.epa.gov/sites/production/files/2014-06/documents/20140602ria-clean-power-plan.pdf>. See Tables 4-7, 4-8 and 4-9.



Table 2. Net societal cost of air pollution avoided by distributed solar PV

Pollutant	25 Year Levelized Value (2014\$) per kWh
Net Social Cost of CO₂	\$0.0311
Net Social Cost of SO_x	\$0.0286
Net Social Cost of NO_x	\$0.0071
Total Net Societal Cost	\$0.0668

Source: “Value of Distributed Generation: Solar PV in Vermont,” Acadia Center. July 2015. Appendix A.

While these costs are a few years old, they remain relevant. A slight change in the generator mix may push average emissions downward, reducing per-kWh social costs. On the other hand, RGGI clearing prices have declined considerably since 2015,²² which in turn pushes up the net externalized social cost of carbon. The total net societal cost avoided by each kWh of distributed solar PV is in excess of \$0.06/kWh, a considerable benefit to Vermont residents. Assuming a 16 percent capacity factor, the 12.9 MW of NEM 2.0 PV installed in 2017 will generate over \$1 million in avoided societal air pollution costs. All NEM PV in Vermont is responsible for well over \$10 million in avoided societal air pollution costs annually.

3.5. Economic Benefits

Distributed solar PV brings considerable economic benefits to Vermont outside of utility system costs and benefits. These benefits relate to tax payments made within Vermont, the employment of Vermont citizens, and the increase in Vermont’s gross state product (GSP).

While systems under 50 kW are exempt from municipal property tax,²³ systems 50 kW and larger are assessed an annual \$4.00 per kW Uniform Capacity Tax (UCT).²⁴ These larger systems are responsible for municipal property tax, on the order of \$17.00 per kW_{AC}.²⁵ Vermonters employed installing or maintaining solar facilities pay Vermont income tax, as do corporations earning profits in solar businesses.

To calculate the annual tax payments made by NEM project owners in 2017, we assumed that Category I systems were sized 7 kW, the historical average. We assumed that Category II and Category III systems

²² RGGI, Inc. “Allowance Prices and Volumes.” www.rggi.org. Accessed December 6, 2017. Available at: <https://www.rggi.org/Auctions/Auction-Results/Prices-Volumes>.

²³ 32 V.S.A. § 3802(17).

²⁴ 32 V.S.A. § 8701.

²⁵ If a NEM solar system, the municipal property tax assessment is made as if the system were sized 50 kW smaller.

were sized as large as possible within their category’s respective size limit (150 kW and 500 kW, respectively), in order to take advantage of economies of scale.²⁶

Table 3. 2017 Estimated Vermont solar PV NEM 2.0 system tax obligations

NEM Category	Total (kW)	Assumed Project Size (kW)	Assumed # Projects	Muni Property Tax Rate (\$/kW)	Muni Property Tax (\$)	UCT	Total
Category I	9,464	7	1,352	\$0	\$0	\$0	\$0
Category II	2,175	145	15	\$17	\$23,753	\$8,701	\$32,454
Category III	1,240	413	3	\$17	\$18,167	\$4,960	\$23,127

PSD March 1 2018 Comments, Vermont tax code, Email from John Chaimanis.

As Table 3 indicates, Category I NEM 2.0 projects installed in 2017 will have no Vermont tax obligation. Category II NEM 2.0 projects will have a combined \$32,454 of annual state and local tax obligation, for each year the project remains operational. Category III NEM 2.0 projects have a combined \$23,127 of annual state and local tax obligation for each of their expected 30 years of future operation. The NEM 2.0 projects built in 2017 will pay an estimated \$55,600 in taxes annually.

This estimate of local taxes is only for NEM 2.0 installations in 2017, for one year of tax payments. The entire fleet of NEM solar in Vermont is considerably larger: Vermont’s total net metered installation base is more than 13 times more than the 2017 NEM 2.0 installation. In Vermont’s largest service territory, Green Mountain Power (GMP), there were 50,300 kW of Category II and Category III solar installations for 2016 and 2017 combined. As shown in Table 4, the combined tax payments for NEM systems in the GMP territory in 2017 were estimated to be \$870,000 for those two years of installations. If we presume the fleet distribution is constant for all years of GMP NEM installed solar, we can scale the tax payment by the ratio of all GMP solar to the 2016-2017 solar, arriving at an estimated \$1,720,000 per year.

²⁶ This assumption was made because while some sites do not allow for a maximum-sized Category II or Category III project, many projects are sized at the maximum.



Table 4. 2017 estimated tax obligations for all NEM solar installed in the Green Mountain Power territory

NEM Category	Total (kW)	Assumed Project Size (kW)	Num Assumed Projects	Muni Property Tax Rate (\$/kW)	Muni Property Tax (\$)	UCT	Total
Category I	22,000	6.4	3453	\$0	\$0	\$0	\$0
Category II	10,200	83.6	122	\$17	\$68,333	\$40,800	\$109,133
Category III	40,100	514.1	78	\$17	\$603,333	\$160,400	\$763,733
Total 2017 Taxes for GMP Installations							\$872,866

Source: GMP February 1, 2018 Comments, Vermont tax code; Email from John Chaimanis.

Installing solar PV systems requires labor, both on-site and off-. Because Vermont has a personal income tax, wage-earners in Vermont contribute to Vermont’s tax revenue. Additionally, Vermont’s corporate income tax also add to Vermont’s coffers. Estimating the contribution is challenging and imperfect. Nevertheless, we provide some numbers to give a sense of scale.

A job is work for one person, for an indeterminate amount of time. A job-year, on the other hand, is the amount of labor productivity one person can generate in one year – or six people in a two-month window, or one half-time employee over two years. We used the National Renewable Energy Laboratory’s Jobs and Economic Development Impact (JEDI) model to estimate the number of direct, indirect, and induced job-years required for 1000 kW of Category I, Category II, or Category III projects.

A direct job-year is a job-year of employment hired directly by the solar project. An indirect job-year of employment is a job-year of work for the project’s supply chain. An induced job-year of work relates to the job-years created in the economy because the wages made by the direct and indirect employees are spent in the economy, stimulating (or, inducing) additional jobs.

The results of the JEDI modeling are below. Table 5 details the construction job-years per 1000 kW of solar installed in Vermont in 2017, by project size. It also shows the higher per-kW costs associated with labor for small systems.

Table 5. Construction job-years per 1000 kW solar installed in Vermont in 2017, by size

	Direct (Job-Years)	Indirect (Job-Years)	Induced (Job-Years)
Category I	13.5	10.2	4.9
Category II or Category III	6.6	4.7	2.7

Source: NREL JEDI PV12.23.16.

Solar installations require ongoing operations and maintenance expenditures. Though those efforts are much smaller on an annual basis, they are applicable for each and every year of the 30-year project. Table 6 details the number of direct, indirect, and induced job-years over a 30-year Vermont NEM PV project’s lifetime, by size.



Table 6. 30 years of operation and maintenance job-years per 1000 kW solar installed in Vermont in 2017, by size

	Direct (Job-Years)	Indirect (Job-Years)	Induced (Job-Years)
Category I	9.0	1.0	1.0
Category II or Category III	6.0	0.0	0.0

Source: NREL JEDI PV12.23.16.

Combining the total installed capacity of systems in 2017 (Table 3) and the job impacts (Table 5 and Table 6) allows for the determination of the number job-years worked in 2017 associated with the 2017 NEM 2.0 PV installations. Table 7 details the job impacts for the NEM 2.0 installations in 2017; the total NEM job-year impact in 2017 is approximately 3.25 times larger than shown in Table 7 because the total NEM PV installed in Vermont in 2017 was approximately 3.25 times larger than the NEM 2.0 PV.

Table 7. 2017 employment impact of 2017 NEM 2.0 PV installations, including 6-months operations and maintenance

	Direct (Job-Years)	Indirect (Job-Years)	Induced (Job-Years)
Category I	129.2	96.7	46.5
Category II	14.6	10.2	5.9
Category III	8.3	5.8	3.3

Source: Calculations from Table 3, Table 5, and Table 6.

To calculate an estimate of the personal and corporate income tax paid as a result of the 2017 NEM 2.0 solar PV installation activity, we require the *direct* job-years worked, the typical hourly wage, and the estimated personal income tax rate associated with the wage. JEDI’s capacity weighted average solar PV hourly wage for Vermont, weighed by 1.03 to account for regional differences, is an estimated \$21.07 per hour.²⁷ Therefore, the estimated wages paid to employees who designed, built, and maintained the 2017 NEM 2.0 PV installations total \$6,688,000. Given Vermont’s effective personal income tax rate of 2.0 percent for wages at or around \$42,700 per year,²⁸ a rough estimation is that Vermont employees who worked on NEM 2.0 solar projects in 2017 paid approximately \$133,800 in state income taxes. Calculating corporate taxes is even more challenging. One way to estimate the actual corporate income taxes paid is to recognize that corporate income taxes paid in Vermont in FY2015 totaled \$111.8 million; personal income taxes in the same period were \$722.2 million. If we assume the same ratio applies to

²⁷ U.S. Energy Information Administration, “Capital Cost Estimates for Utility Scale Electricity Generating Plants,” November 2016. Table 4. Available at: https://www.eia.gov/analysis/studies/powerplants/capitalcost/pdf/capcost_assumption.pdf

²⁸ Vermont Joint Fiscal Office. 2017. “The Vermont Tax Study 2005—2015.” Figure 14. Available at: <http://www.leg.state.vt.us/jfo/reports/2017%2010%20Year%20Tax%20Study%20Full%20Report%20Compressed.pdf>.



the solar industry in Vermont, and that 2017 calendar year maintains the same ratio as the 2015 fiscal year, we would expect solar businesses to have paid \$19,600 in corporate income taxes.

The 12.9 MW of NEM 2.0 projects resulted in an estimate in excess of \$200,000 in property, UCT, and income taxes paid on \$6,365,000 in wages. A more complete economic analysis using a tool like IMPLAN would also include the sales tax generated by the spending of earned wages, and operations and maintenance spending associated with business operations such as lease payments and insurance. Although not calculated for this project, a similar analysis performed in 2015 demonstrated that the Vermont GSP impact is about 3.5 times the direct job-year income;²⁹ if that ratio holds true for the 2017 NEM 2.0 projects the GSP impact would be on the order of \$22 million.

4. COST-SHIFTING

4.1. Approach

In their most simplified form, electricity rates are set by dividing the utility's revenue requirement (in millions of dollars) over its sales (typically measured in kilowatt-hours).

$$\text{Rates} = \frac{\text{Revenue Requirement } \$}{\text{Sales (kWh)}}$$

Rate impacts are primarily caused by two factors:

- 1. Changes in costs:** Holding all else constant, if a utility's revenue requirement decreases, rates will decrease. Conversely, if a utility's revenue requirement increases, rates will increase. Distributed solar can avoid many utility costs, which can reduce utility revenue requirements. Many of these costs are captured in the avoided costs used for screening energy efficiency.³⁰
- 2. Changes in electricity sales:** If a utility has to recover its revenues over fewer sales, rates will increase. This is commonly referred to as recovering "lost revenues" and is an artifact of the decrease in sales, not any change in actual costs incurred by the utility. Rather, the rate increase is due solely to the *distribution* of costs among solar and non-

²⁹ Vitolo, T., M. Chang, T. Comings, A. Allison. 2015. *Economic Benefits of the Proposed Coolidge Solar I Solar Project*. Prepared for Coolidge Solar I, LLC, November 3, 2015, table 1.

³⁰ See: Order Re: EEU Avoided Costs, Externality Adjustments, and Other Screening Components for 2017-2018 Time Period, Docket EEU-2015-04, October 20, 2017.

solar utility customers. This impact is therefore only relevant to a rate impact analysis, which captures distributional impacts, not a cost-benefit analysis or value of solar analysis.

Whether distributed solar increases or decreases rates will depend on the magnitude and direction of each of these factors. If in one year distributed solar decreases the utility's revenue requirement by a larger percentage than sales decrease, rates can decline.³¹ However, costs and benefits may not always be aligned temporally. In the near term, the utility will still have to recover its sunk costs—the investments that the utility made in the past and amortized over many years.³² These sunk costs continue to be recovered through the utility's revenue requirement until they have been fully depreciated. Over time, these sunk costs will decline, while the avoided costs associated with distributed solar may continue to accumulate. For this reason, it is important to account for both of these effects over an appropriately lengthy time horizon.

In the long run, if the average net avoided costs to the utility system (in \$/kWh) are equal to the credit received by the solar customer, then no cost-shifting over the study period is expected to occur.³³ If the net avoided costs are less than the credit received by the solar customer, rates will increase and cost-shifting will occur. Similarly, if net avoided costs are greater than the credit received, then a reduction in rates may occur.

4.2. Cost-Shifting Inputs

To analyze whether and to what extent cost-shifting is occurring, we conducted an analysis for customers of Green Mountain Power. We conducted two separate analyses:

- 1) An analysis of cost-shifting attributable to the NEM 2.0 program, and
- 2) An analysis of cost-shifting attributable to all net metering through December 31, 2017 (i.e., NEM 1.0 and 2.0 combined).

Both analyses utilized the same methodology and the following inputs:

³¹ Whether or not rates actually decrease is dependent upon whether the utility's revenues are recalculated and new rates are set. However, there may be a lag of several years before a new rate case commences and new rates are set.

³² The utility is also allowed the opportunity to recover a return on its investments.

³³ The net avoided costs account for both the benefits and any additional costs imposed on the utility system by distributed solar.

- **Study period:** For both studies, we analyzed the impacts of customer bills over a 25-year period, using current penetration levels. This was done to capture the full lifetime of costs and benefits.
- **Net avoided costs of solar that impact customer bills:** We included annual discounted estimates for avoided energy, avoided generation capacity, avoided transmission and distribution capacity as included in the Commission’s most recent order on avoided costs from October 2017.³⁴ Average transmission line losses and avoided environmental compliance costs (i.e., RGGI) are included in these values.³⁵ Wholesale market price impacts (DRIPE) were excluded, as these are largely experienced by customers outside of Vermont. Risk benefits and environmental externalities were also excluded, as these do not flow through directly to customer bills. REC values were also excluded, as these were not in place when the AESC values were initially developed.

The solar capacity contribution factor for calculating capacity benefits relied on the values provided by ISO New England’s 2017 Forecast Report of Capacity, Energy, Loads, and Transmission (the CELT Report). These values decrease from 37.5 percent in 2017 to 29.6 percent in 2026.³⁶

- **NEM compensation rates:** For the NEM 2.0 analysis, we assumed a compensation rate of 15.8 cents/kWh, based on the weighted average of NEM 2.0 Category I, Category II, and Category III customers. We excluded REC adders from the compensation, as we also excluded the avoided costs attributable to RECs (as noted above). This was done to avoid skewed results from including RECs on one side of the ledger (costs) but not the other (benefits).

For the combined NEM 1.0 and NEM 2.0 analysis, we assumed a weighted average compensation rate of 19.6 cents/kWh based on the proportion of NEM 1.0 and NEM 2.0 capacity in Category I, Category II, and Category III categories for Green Mountain Power.³⁷ However, after 10 years, the compensation was reduced to the blended rate,

³⁴ Order Re: EEU Avoided Costs, Externality Adjustments, and Other Screening Components for 2017-2018 Time Period, Docket EEU-2015-04, October 20, 2017.

³⁵ Hornby, R., A. Rudkevich, B. Schlesinger, S. Englander, J. Neri, J. Goldis, K. Amoako-Gyan, H. He, A. Rivas, and R. Tabors. 2015. *Avoided Energy Supply Costs in New England: 2015*. Prepared for the Avoided-Energy-Supply-Component (AESC) Study Group, revised April 3, 2015, pages 4-2 and 5-3.

³⁶ ISO New England. *Forecast Report of Capacity, Energy, Loads, and Transmission* (the CELT Report). Table 3.1.2 - Forecast of Cumulative BTM Solar PV Estimated Summer Seasonal (July 1st) Peak Load Reduction by State. 2017.

³⁷ Based on installations through December 2017, as reported by GMP in its February 2018 filing.

and customers who currently offset all of their bills through net metering³⁸ were also assessed a non-bypassable rate of \$0.01281/kWh and a monthly customer charge of \$13.86.³⁹

Table 8. Calculation of weighted average NEM compensation rate⁴⁰

		Number of Customers	MW	Compensation (cents/kWh)
NEM 1.0	CATEGORY I	6,356	38.6	20.0
	CATEGORY II	413	32.2	20.0
	CATEGORY III	113	58.4	20.0
NEM 2.0	CATEGORY I	940	5.8	15.9
	CATEGORY II	28	8.4	15.9
	CATEGORY III	2	1.0	14.9
Weighted Average Compensation				19.6

- Customer counts, energy consumption, and revenue requirements:** For simplicity, we assumed that any rate impacts would be shared proportionately across the customer classes. To estimate impacts on residential customer bills, we calculated average energy consumption per residential customer based on EIA Form 861. The number of Green Mountain Power residential customers reported for 2016 was 220,612, with average residential customer usage of 564 kWh/month.⁴¹ Usage levels were held constant for the duration of the study period (25 years). The revenue requirement was also taken from EIA 861 and was held constant for the duration of study period.
- Annual net metered solar generation:** For the NEM 2.0 analysis, the average customer’s PV system was modeled at a size of 15.67 kW_{AC}, based on the weighted average size of NEM 2.0 generators.

³⁸ We assumed that 50 percent of customers currently zero out their entire bill through NEM credits.

³⁹ See: Hofmann, Sarah. Vermont Public Service Board Rule 5.100 – Net-metering. Presentation to the Legislature, January 31, 2017, slide 19. Available at <https://legislature.vermont.gov/assets/Documents/2018/WorkGroups/House%20Energy%20and%20Technology/New%20Net%20Metering%20Proposed%20Rules/W~Sarah%20Hofmann~Net%20Metering%20Presentation~1-31-2017.pdf>

⁴⁰ Based on NEM 2.0 installations through December 2017, as reported by GMP in its February 2018 filing, and NEM 1.0 installations reported by Robert Dostis of GMP in testimony before the Senate Finance Committee on February 15, 2018.

⁴¹ U.S. Energy Information Administration. 2016. *EIA Form 861*.



For the combined analysis, the average customer's PV system was modeled at a size of 18.39 kW_{AC}, which is the weighted average across all sizes of net metered generators at Green Mountain Power.⁴²

For both analyses, we used NREL's PV Watts calculator to estimate that these average solar installations produce 20,042 kWh annually for NEM 2.0 and 23,520 kWh annually for the combined analysis. This is based on an average capacity factor of 14.6 percent.⁴³

Using these inputs, the cost-shift was calculated as the reduction in utility revenues due to PV generation that is not offset by the avoided costs to the utility system.

The total NEM credits paid by the utility to NEM customers can be expressed as:

$$NEM\ Credits = (TotSolarGen * Compensation\ Rate) - Forfeited\ Credits$$

Where:

NEM Credits is the *gross* reduction in revenues (including pass-through supply revenues) following the addition of distributed solar generation.

TotSolarGen is the total quantity (kWh) of solar generation produced by net metered customers annually.

Compensation Rate is the average per kWh compensation rate received by net metered customers.

Forfeited Credits are those that are not used within 12 months. For the combined NEM 1.0 and NEM 2.0 analysis, we assume that approximately \$450,000 in credits is forfeited annually, based on GMP's projection for 2018 in its most recent rate case.⁴⁴

We estimated the annual NEM Credits for NEM 2.0 totaled \$3.1 million in 2017. For the combined analysis, we estimated the annual NEM credits (less forfeited revenues) to be approximately \$36

⁴² Based on NEM 2.0 installations through December 2017, as reported by GMP in its February 2018 filing, and NEM 1.0 installations reported by Robert Dostis of GMP in testimony before the Senate Finance Committee on February 15, 2018.

⁴³ National Renewable Energy Laboratory. "PV Watts calculator." Available at: <http://rredc.nrel.gov/solar/calculators/pvwatts/system.html>.

⁴⁴ Case No. 17-3112-INV, GMP Responses to DPS Third Round of Discovery Requests, Attachment GMP.DPS.Q39, July 10, 2017.



million annually for the first ten years, declining to \$26 million annually in later years, due to NEM customers being subject to a customer charge and certain non-bypassable charges.⁴⁵

The impact to the total revenue requirement that must be collected from customers due to net metering is reduced by the net avoided costs to the utility system. This can be expressed as the net lost revenues:

$$Net\ Lost\ Revenues = NEM\ Credits - (NetAC * TotSolarGen)$$

Where:

NetAC is the net avoided cost to the utility system per kWh of net metered solar generation.

The retail rate must then be adjusted to collect the net lost revenues, but it must do so over a reduced number of kilowatt-hours. The change in the retail rate then becomes:

$$Change\ in\ Retail\ Rate = \frac{Net\ Lost\ Revenues}{kWh_{PV}}$$

Where:

kWh_{PV} is the number of kilowatt-hours consumed after the addition of distributed solar.

The change in the retail rate can then be multiplied by the average customer energy consumption to determine monthly and annual bill impacts.

4.3. Results of Cost-Shift Analysis

Distributed generation can provide a host of benefits to the electric utility system and to society, ranging from avoided energy and capacity costs to reduced impacts on the environment and economic development. When all of these impacts are accounted for, the societal benefits can be quite large. Even

⁴⁵ See: Hofmann, Sarah. Vermont Public Service Board Rule 5.100 – Net-metering. Presentation to the Legislature, January 31, 2017, slide 19. Available at <https://legislature.vermont.gov/assets/Documents/2018/WorkGroups/House%20Energy%20and%20Technology/New%20Net%20Metering%20Proposed%20Rules/W~Sarah%20Hofmann~Net%20Metering%20Presentation~1-31-2017.pdf>. We assume that 50 percent of NEM customers do not generate enough energy to fully offset their bills, and thus the mandatory customer charge and other non-bypassable charges would be incurred anyway.

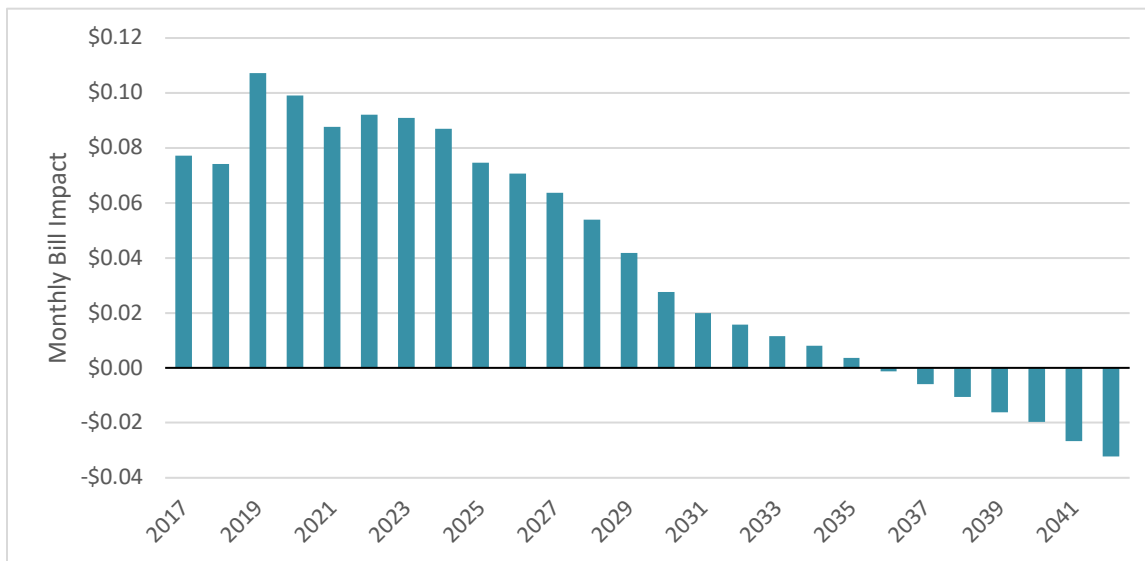
when net metering is clearly cost-effective from a societal perspective, however, it is possible that non-net metered customers will experience higher rates due to net metering. This is because a cost-shifting analysis only accounts for the impacts of net metering at the utility system level, not at the societal level.

The results of our analyses for both the NEM 2.0 program only and the combined NEM 1.0 and NEM 2.0 programs are presented below. The scale of the graphs for each analysis has been kept the same to allow comparison of the magnitude of cost shifting across both analyses.

NEM 2.0 Cost-Shift Analysis Results

Accounting for only the utility system impacts, there is evidence of a very slight cost-shift from Green Mountain Power NEM 2.0 customers to non-net metered customers. Over the study period, this cost-shift averages only \$0.04 per month for the typical residential customer. Moreover, the impact is highest in the early years, but declines in later years due to higher avoided costs in later years. This indicates that NEM 2.0 is largely aligned with avoided utility costs and is causing very little cost shifting.

Figure 2 Average monthly residential bill impacts from NEM 2.0 over study period



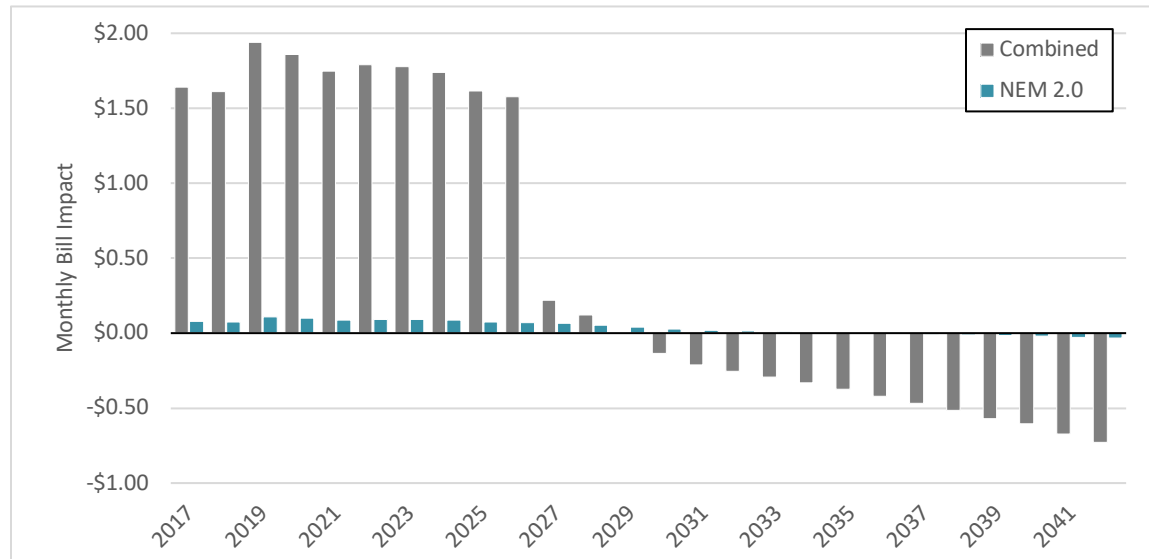
Combined NEM 1.0 and NEM 2.0 Cost-Shift Analysis Results

While current NEM compensation rates are resulting in very little cost shifting, NEM 1.0 customers are compensated at a higher rate. For NEM 1.0 and NEM 2.0 customers combined, the compensation rate averages 19.6 cents/kWh for ten years, after which it declines to the blended rate and customers are required to pay non-bypassable charges and a monthly customer charge. We found that the combined NEM 1.0 and NEM 2.0 programs result in modest cost shifting of \$0.46 per month for the typical residential customer, averaged over the 25-year study period. Importantly, the analysis shows that cost-shifting is highest in the initial years (\$1.64 per month in 2017) but declines and actually reverses in the



later years (to $-\$0.73$ per month), due to the reduction in NEM credits and the higher avoided costs in later years. After 2029, net metering begins to reduce customer bills for non-participants.

Figure 3. Average monthly residential bill impacts over study period for NEM 1.0 and NEM 2.0 combined



Summary of Results

In sum, our analysis found very little cost shifting occurring under NEM 2.0 rates – averaging only \$0.04 per month for the typical residential customer over the 25-year study period. Reducing cost shifting was one of the primary purposes of lowering NEM compensation to the current level, and this action has been effective.

NEM 1.0 compensation levels were set when penetrations were lower in order to promote solar growth. Because NEM 1.0 customers are credited at a higher rate than NEM 2.0 customers, the cost-shift per megawatt of installed capacity is significantly higher for the combined NEM 1.0 and NEM 2.0 programs than for NEM 2.0 alone – averaging \$0.46 per month for the typical residential customer, averaged over the study period. However, the cost shift onto non-NEM customers disappears and reverses in later years as the NEM 1.0 credit falls to the blended rate and customers are no longer allowed to zero out their monthly bills.

There are several important points to keep in mind when considering the results of the cost-shifting analysis:

- The bill impacts most relevant to this proceeding are those associated with NEM 2.0, which amount to \$0.04 per month for a residential customer, averaged over the study period. We also present the combined bill impacts for both NEM 1.0 and NEM 2.0 for completeness, but the impacts of NEM 1.0 represent past policy decisions that are equivalent to sunk costs that should not drive policy decisions going forward.

- The bill impacts do not account for the unquantified benefits described above, including economic benefits, reduced supply risk, non-embedded costs of carbon and other environmental externalities.
- We calculated the bill impacts at penetration levels as of December 31, 2017, and we based them on the most recently approved avoided cost estimates. The bill impacts will change if NEM penetration changes, compensation levels change, or avoided cost estimates change. For this reason, cost shifting estimates should be revisited frequently. However, we do not expect the avoided costs to change dramatically from one year to the next.

5. FINAL RECOMMENDATIONS

As discussed above, net metering provides tremendous economic value to Vermont, while cost-shifting is modest and has been nearly eliminated with NEM 2.0 compensation levels. As changes to NEM compensation are contemplated, the full ramifications should be considered. Financial considerations play a critical role in spurring—or impeding—adoption of distributed generation. A policy decision such as a change in net metering compensation will directly impact the economics of investing in distributed solar, and thus customers’ willingness to adopt the technology. This in turn will affect how much distributed solar is ultimately developed in Vermont and whether the Vermont succeeds in achieving its policy goals tied to the development of distributed solar.

We recommend a NEM solar rate that supports the installation of at least 20 MW each year. The NEM ratemaking decision must carefully weigh eight factors, including: balance costs and benefits; support the development of renewable energy and economic development; provide price stability; develop markets for renewable projects (and energy efficiency projects); promote water and air quality; reduce climate change pollution and negative economic exposure to federal regulations; support distributed generation; and promote diverse technologies. A NEM solar rate that incents solar installations in excess of 20 MW each year achieves those goals. This is because the net metered PV cost-shifting is minimal, because solar projects protect Vermonters from both changes in fuel prices and federal policies, and because NEM solar PV is non-emitting, distributed, and remains a small component of New England’s energy mix.

We recommend the REC adjustment be reduced to +/- \$0.0275 per kWh. Parties have noted that the REC prices have fallen considerably in recent years. Once as high as \$55/REC, New England Class I RECs are now forecasted to be in the \$20–\$25 range for the next ten years. If the NEM methodology called for the utility to pay for RECs for the entire 30-year life of the project, we would expect to see the difference between customer-sells and customer-keeps RECs to be \$0.025 per kWh if priced fairly. However, the methodology allows for REC payments for the first ten years only, requiring that the customer be paid for the full 30-year value of the RECs within a smaller window of time. Ten years of



payments at \$0.057 per kWh corresponding with 30 years of REC production corresponds to 30 years of payments at \$0.025 per kWh, assuming a 2 percent inflation rate. For this reason, we propose that the REC adder—the difference in payment between a rate where the customer sells the RECs to the utility in perpetuity (though is only paid for the first ten years) and one where the customer keeps the RECs—be \$0.055 per kWh. The NEM 2.0 rates included a \$0.03/kWh payment for customers who sold RECs to the utility and a \$0.03/kWh penalty for customers who did not. We recommend maintaining the symmetry of the NEM 2.0 rates. At \$0.055/kWh, this entails compensating a customer who sells RECs to the utility an additional \$0.0275/kWh, whereas the compensation for a customer who declines to sell RECs be reduced by \$0.0275/kWh.

We recommend a half-cent increase in the siting adjustor for ground-mounted Category II and Category III projects. With respect to siting adjustors, we note that there is a significant number of Category III projects in the queue and that there is greater uncertainty about pace of future development within that size category. Ground-mounted projects have a significantly more burdensome permitting process, and therefore face higher costs and increased uncertainty. Furthermore, there is considerable risk in addressing the preferred site conditions for gravel pits, landfills, and brownfields associated with pre-existing conditions and various interpretations of end-of-project-life expectations. These challenges are significant and may ultimately prove insurmountable for the ground-mounted projects in pre-construction stages. Furthermore, while the long-term trends in solar PV cost have been downward, a bevy of recent economic news and technical requirements will push costs upward in the short term. The recently implemented Section 201 solar tariffs, increasing interest rates, the slower pace of project approval under NEM 2.0, the expiring solar ITC, and increasing wages due to Vermont’s declining unemployment rate all point to higher solar installation prices in 2018.^{46,47,48} These headwinds and the proposed reduction in REC payments lead us to recommend a half-cent increase in the siting adjustor for ground-mounted Category II and Category III projects, consistent with our projections for annual NEM deployment necessary to reach state goals and our call for gradual adjustments to NEM 2.0.

The aggregate result of our proposed REC changes and the siting adjustor changes is that roof-mounted projects that sell RECs would see a net reduction in payment by a quarter-cent per kilowatt-hour, and ground-mounted projects that sell RECs to the utility would have a net increase in payment of a quarter-cent.

46 Executive Office of the President of the United States, “Fact Sheet: Section 201 Cases: Imported Large Residential Washing Machines and Imported Solar Cells and Modules,” January 22, 2018. Available at: <https://ustr.gov/sites/default/files/files/Press/fs/201%20Cases%20Fact%20Sheet.pdf>

47 The Effective Federal Funds Rate has steadily increased from 0.12 in November 2015 to 1.42 in February 2018. See: <https://fred.stlouisfed.org/series/FEDFUNDS>.

48 Vermont’s January 2018 seasonally adjusted unemployment rate was 2.9 percent, continuing a steady decline. The last time it was 2.9 percent was November 2000. See: <http://www.vtlmi.info/Labforce.cfm?qperiodyear=2018&qareatype=01&qadjusted=Y>.