Vermonters for a Clean Environment

To: STATE OF VERMONT PUBLIC UTILITY COMMISSION

Re: Case No. 19-0855-RULE

VCE's Response to Comments on Proposed Revisions to Vermont Public Utility Commission Rule 5.100 Pertaining to Construction and Operation of Net-Metering Systems

Vermonters for a Clean Environment appreciates the opportunity to respond to comments on proposed revisions to Rule 5.100. VCE is focusing our reply comments on the 130+ public comments that have been submitted, most of which say essentially the same thing: "solar is necessary to address climate change and Vermont needs more solar."[1] Some commenters ask the PUC to make no changes to the rates, some people reference investments they have made, and others speak to the importance of generating excess solar in the summer to offset winter electricity costs.

Net-metered solar is part of a system

Net-metered projects are part of a regional electric grid system which currently relies heavily on natural gas power plants to supply electricity throughout the New England region. An important goal of the public commenters is to address climate change which presumably means reducing fossil fuel emissions such as come from gas power plants.

Renewable energy, specifically wind and solar, are weather dependent. In New England's long and cloudy winter weather, addressing climate change with solar means addressing winter weather conditions to maximize solar power output.

Real renewable energy vs. paper contracts

Many of the public commenters oppose a change in the rates of compensation, and some make the point that their system is set up to maximize output in the summer so they can generate enough credits to zero out their electric bill in winter. These paper contracts are maximizing money and return on investment. However, they are not maximizing renewable energy production. If the goal is to address climate change by reducing fossil fuel power plant emissions, it is important to understand the role that each net-metering customer plays in producing real renewable electricity in winter months.

Tilt Angle, Snow, and Shading

Several factors come into play when attempting to maximize solar output in winter months. Most people install solar panels at the summer angle (flatter, with less slope) rather than the winter angle (more upright, with more slope). The typical net-metered installation is designed to produce as much electricity as possible during the summer, usually producing more than is needed for the customer's own use, so that credits build

[1] Some of the recent comments were submitted in response to this 12/5/19 editorial: https://addisonindependent.com/opeds/editorial-vermonts-dps-waging-war-states-solar-industry

up that can be applied to the bill in the winter. This method is not maximizing the potential benefits of net-metered solar in a way that results in the greatest reduction in fossil fuel emissions from natural gas power plants in winter.

When solar panels are at the summer angle, they do not shed snow as well as panels at the winter angle. See *VCE Exhibit 1*, "Snow and Ice on Photovoltaic Devices, an analysis by the Norwegian University of Science and Technology." This Master's thesis examines the problems and offers proposals for solutions to the challenges of snow and ice on photovoltaic devices.

From the Abstract on p. I: "When the modules are all located on the same shed, a high tilt angle can be more convenient than a low one, because it increases the sliding of snow." And, "On the contrary, when panels are located on different sheds, the shading problems leads to the conclusion that a medium tilt angle is the best solution."

The thesis explores numerous issues and ideas for how to address snow and ice conditions on solar panels to increase production in winter. We have all seen fields of solar panels covered with snow, some for extensive periods of time. For example:

Note the close spacing of the panels, such that they shade each other, which would occur even if the snow is removed. This greatly reduces the electricity output, and therefore is not maximizing addressing climate change by reducing fossil fuel emissions. Snow removal and proper spacing of ground-mounted solar to avoid shading are relevant to larger arrays too, not just to net-metered projects.

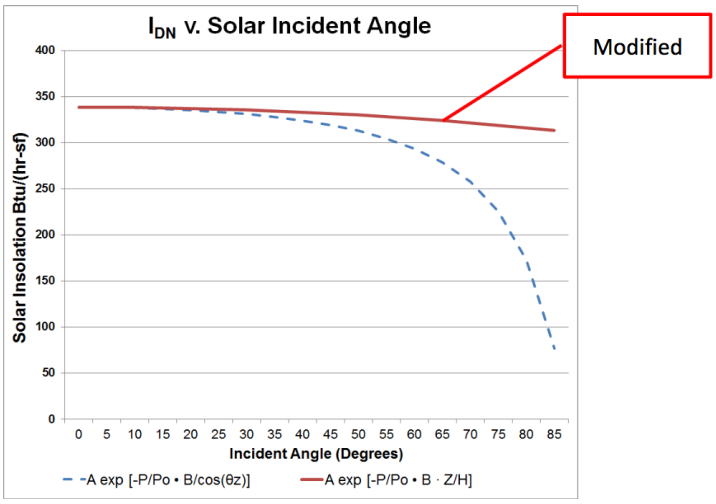
Solar gain in winter months has been underestimated

VCE asked a Vermont registered professional engineer (PE) and certified energy manager (CEM), Curt Freedman to do an analysis of various tilt angles and spacing for a site in Vermont. Mr. Freedman is a published author in solar energy, a solar energy researcher as well as an adjunct professor of renewable energy at Western New England University in Springfield, MA. Although the referenced site is not a net-metered project, the information is relevant to the tilt angle of any solar panel and the spacing of any ground-mounted solar array that involves a series of rows of solar panels when there is a

potential for one array to shade another. See *VCE Exhibit 2*, "Bennington Solar Report Evaluation of Chelsea and Apple Hill Sites."

Mr. Freedman has calculated that the traditionally accepted formula used by developers to determine solar gain in winter months is inaccurate, and dramatically underestimates the winter sun's potential to produce electricity.

See p. 9 of his report, which contains this graph (I_{DN} is the direct solar insolation):



The dashed blue line shows what solar developers have been using as their model for winter months. The red line shows Mr. Freedman's calculated solar potential which is much greater than has been previously assumed. Anyone wishing to speak with Mr. Freedman about his calculations and conclusion is welcome to contact him directly.

In his report, Mr. Freedman evaluates tilt angle and spacing. The results of his calculations show that solar gain can be maximized by paying attention to tilt angle and spacing. Mr. Freedman concluded that power production would increase significantly if the pitch of the panels would be increased by approximately 5% if the panel pitch would be increased from 5° to 30°. In addition, the steeper angle would more readily allow snow to slide off.

The Masters thesis also supports the proposition that northern areas have great energy potential due to snow reflections:

> Snow is one of the major causes of energy production loss for photovoltaic devices in northern countries. As a matter of fact in coldest months snow creates even a total coverage of modules that does not allow any electricity production. However, despite common beliefs, northern countries have great energy potential also in winter time, due to high albedo values caused by snow reflections (Scharmer and Greif 2000). As a matter of fact, 74% of PV resources were installed in countries that experience some amount of snowfall (Becker et al. 2007). *[VCE Exhibit 1, p. 11]*

Time of Year Rates, or Percentages

In VCE's Nov. 1 comments, we suggested the PUC consider time of year rates. Another way of looking at it is to develop a rate schedule that creates incentives for producing electricity from net-metered projects in winter. Customers who invest in battery storage could be compensated for that storage, though that would need to be coordinated with the rates and methods used by utilities that use customers' batteries.

Or perhaps the annual payments could be based on percentages, whereby the customer's actual usage is compensated at a higher rate, while the period of the year where the customer is drawing power from the grid is compensated at a lower rate. Some parties to this rule update may have accurate data on the percentage of the year that solar arrays produce power compared to when they do not.

It is most important for net-metered solar customers to understand that when they have an air source heat pump or electric hot water heater or electric vehicle, in most of Vermont's utility service territory any charging or heating that takes place when the sun is not shining is coming from grid power, the majority of which is from fossil fuel generators. One goal of this rule update should be to reduce or eliminate the ability for people to build up credits to use in the winter so that there is incentive for snow removal from panels. If Vermonters want the transition to renewable energy to be real rather than based on credits, paper contracts and gimmicks, it is important to support the system by maximizing solar output during winter months.

Summary

Vermonters who live off-grid and depend on solar electricity must clean the snow off the panels in winter to get power. Keeping the solar panels at the flatter summer angle produces more power than is needed in summer, while reducing snow shedding in winter. Keeping the solar panels at the steeper, winter angle results in more rapid shedding of snow, and produces much-needed electricity during cloudy winter months.

Net-metering customers who are part of the regional system need to absorb this concept into their thinking if they want to address climate change by reducing fossil fuel emissions. If net-metered panels are covered with snow in winter and are not cleaned off, they are not doing anything to reduce emissions in the regional grid. If rows of panels are shading each other, they are not maximizing production.

The current system might reduce electric bills, so if money is the only object, then the current system that so many commenters seem to support is the result they will prefer. However, based on the majority of the comments that mention climate change, they would seem to support making a change that would maximize electrical output from net-metered solar projects in winter, so they really are working to reduce fossil fuel emissions from the region's fossil fuel power plants.

Respectfully submitted this 6th day of December, 2019 by

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