STATE OF VERMONT
PUBLIC SERVICE BOARD

In Re: Petition of SSE New Haven Solar II LLC ("SSE") for a Certificate of Public Good, pursuant to 30 VSA §219a and Board Rule 5.100 authorizing the installation and operation of a 350 kW net metered ground mounted solar electric generation facility to be located in New Haven, Vermont.	**)**	**NMP -5978**

PREFILED TESTIMONY OF

ROBERT J. AMELANG

ON BEHALF OF THE TOWN OF NEW HAVEN

April 13, 2015

Revised April 17, 2015

<u>Summary of Testimony</u>

Mr. Amelang describes the economic impact of this proposed project and other similar sized net metered solar electric generation facilities generally in the state of Vermont. He also describes the impact on system reliability of the proposed solar electric generation facility.

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1. Q. What is your name and business affiliation?

A. My name is Robert J. Amelang. I am a consultant to the Town of New Haven.

2. Q. Please describe your educational background and business experience.

A. I retired in November 2013 from Green Mountain Power (GMP). I had worked since 1987 for Central Vermont Public Service (CVPS) until acquisition by GMP. In 2011 GMP officers replaced those of CVPS and I began working under GMP management at that time. The acquisition was effective in 2013. At CVPS/GMP I first worked in generation and integrated resource planning. I later was assigned the role of a senior internal consultant, where I worked for various departments such as power supply, finance, accounting, rates and legal. I provided support for major CVPS filings to the Vermont Public Service Board ("Board"). Prior to CVPS I worked for another utility and several utility consultants. I graduated from Iowa State University with a Bachelor of Science in electrical engineering: power specialty in 1973. I was a registered professional engineer in Iowa and Nebraska.

3. Q. Has your CVPS/GMP work experience provided you with experience with net metering and solar generation?

A. Yes. In my consultant role at CVPS I worked in a department that included the experts responsible for calculating rates and preparing the associated rate filings to the Board. It was common for all of us in that department to share information about all our projects. Net metering was a project for which we all had a keen interest. Also, while officially working for

CVPS, but under direction of GMP management, I provided analytical support and review for the first detailed study by GMP of the value of solar generation.

4. Q. Have you previously testified before the Board?

A. Yes. I filed testimony in cases involving the McNeil generation station and the proposed East Georgia generation station.

5. Q. What is the purpose of your testimony?

A. I describe the economic impact of this proposed SSE New Haven Solar II LLC ("SSE") project and other similar sized net metered solar electric generation facilities generally in the state of Vermont. I also describe the impact on system reliability of the proposed solar electric generation facility.

6. Q. Have you published an article on the economic impact of net metering?

A. Yes. The Vermont Digger published my article entitled, "Shining Light on Solar Power Costs" on November 2, 2014. (http://vtdigger.org/2014/11/02/bob-amelang-shining-light-solar-power-costs/)

7. Q. Please describe your role in the Board proceeding involving East Georgia generation station ("East Georgia") and the outcome.

A. East Georgia was a proposed 30 MW natural gas fired generation station that sought Certificate of Public Good approval from the Board in the 1990s. I determined that the approval of East Georgia would increase costs and thus electric rates. After presenting this information to management, CVPS elected to intervene in the East Georgia Board filing. I submitted testimony showing that East Georgia would increase power costs and requested that the Board not approve the East Georgia project. My testimony showed that the power costs of East Georgia would be higher than that of alternative power sources. The Board rejected the East Georgia request for a Certificate of Public Good and the project was not built. CVPS would have paid a load based share of the East Georgia power costs and the first year CVPS power costs savings were $5 million.

8. Q. What is the economic impact of the proposed SSE New Haven Solar II LLC ("SSE") project and other similar sized net metered solar electric generation facilities generally in the state of Vermont?

A. The economic impact is that the SSE project, together with the many other solar net metered generation projects expected to be installed at current high growth rates, will eventually cause future electric rate increases.

Net metered generation under current Vermont rules acts to decrease revenues and increase expenses for electric utilities. The net metered generation economic impact is proportional to the quantity of such generation capacity installed. For small quantities of installed net metered generation capacity, there would be no noticeable impact on utility electric rates. Utility revenues and expenses normally fluctuate up and down due to uncontrollable forces such as the economy and the weather. Utilities can also defer and amortize costs. Utilities have a financial inertia that allows them to tolerate revenue reductions and expense increases for some time without significant problems. However, as the total installed net metered generation capacity increases past a certain point, utilities will be motivated to file for a rate increase, unless there are significant offsetting expense reductions.

Electric utility rates are based on forecasts of energy sales and expenses. Expenses here include also a return on equity investment and bond interest payments. Both revenues and expenses can change unexpectedly over time, for a wide variety of reasons. One cannot say precisely when a certain amount of net metered generation will cause a rate increase and how much that increase would be. There are simply too many variables affecting electric rates. The rate impact of net metered generation could be offset by large expense reductions or corresponding revenue increases. But if all other variables affecting electric energy sales and expenses are kept constant, a constantly increasing quantity of net metered generation will ultimately lead to rate increases.

Even though electric rates are changed due to various factors affecting revenue and expenses, one can calculate the rate impact, due specifically to net metered generation. For example, if rates are increased by 3%, one could determine that net metered generation contributed to 2 % of the increase. The same applies to rate decreases. Reversing the prior example, if rates decrease by 2%, absent net metered generation the decrease would have been 4%.

Solar net metered generation provides both a capacity and energy benefit. That is, solar generation generates the highest hourly energy in the summer, when the New England power system peaks. Also, to a lesser extent, solar generation saves costs by reducing loading on the New England transmission system. Due to differences in New England power tariff billing, solar generation provides a much lower transmission capacity benefit than the generation capacity benefit.

For both the generation and transmission system capacity benefits, solar net metered generation is subject to a law of diminishing returns. This law is based on the phenomenon in which the time at which electric load peaks occurs ("peak hourly load") shifts to later in the day as more and more solar generation is operating. Thus, new solar net metered generation such as SSE has less benefit than those solar projects already installed.

GMP provides electric service to New Haven and 77% of the energy sales of Vermont's electric customers. Thus, henceforth I will describe economic impact in terms of impact on GMP customers. Also, since net metering rules and electric rates vary somewhat among Vermont utilities, specifying GMP simplifies the description. Although tailored for GMP, the following narrative will apply generally to all other Vermont utilities.

New net metered generation reduces GMP net income due to two effects. First, net metered generation causes a reduction in GMP revenue that is considerably larger than the expense reduction due to the new generation. The following is a simple example using rough numbers in terms of the impact on a per unit of kilowatt-hour ("kWh") energy basis. For each kWh of solar net metered generation, GMP loses roughly 15 cents per kWh of revenue. The solar energy results in a GMP expense reduction of 9 to 10 cents per kWh.

The second effect of net metered generation is due to the mandate that Vermont, utilities pay an additional premium for energy produced from the net metered generation facilities. GMP pays a surcharge for all energy from net metered generation, which is currently 4.3 cents/kWh for the larger net metered generation facilities installed after the end of 2014. GMP pays 6 cents/kWh to net metered generation facilities installed prior to January 1, 2015. These payments extend for ten years of operation of the solar projects.

In the short run, this reduction in net income means GMP will have less money to spend to maintain and upgrade its electrical infrastructure. This will reduce service quality by reducing reliability and power quality. There are minimum reliability standards, so GMP has limited ability to reduce spending on its infrastructure. If GMP makes no reductions in its infrastructure related expenditures, the lower net income from net metered generation will result in a lower return on equity investment. As with reliability, there are minimum requirements for return on equity rates. After net income reductions reach a critical level, GMP must file at the Board for a rate increase to maintain reliability and return on investment. Thus, in the long run, net metered generation will cause rate increases.

9. Q. If net metered generation reduces GMP revenues, why did the Board approve a rate decrease in the last GMP rate proceeding?

A. There are several reasons why GMP could reduce its rates in its last rate case. First, GMP has the benefit of significant expense reductions due to the CVPS acquisition. Second, GMP set a goal of zero rate increase, which required mitigation actions of cost reductions or deferring costs to later years. The mitigation actions included commissioning a new depreciation study that resulted in a lower depreciation expense of about $5 million per year (GMP Response to AARP's First Set of Discovery Requests, AARP:PET.1-12, Docket No. 8190). Another mitigation action was a power supply purchase that covered both 2015 and 2017 open positions that effectively reduced 2015 power costs (AARP:PET.1-15). Third, GMP had other cost savings and adjustments such as revenue from the Vermont Yankee revenue sharing agreement. These expense reductions were greater than the net income reduction caused by net metered generation.

10. Q. Did you have personal experience with GMP actions taken to reduce the rates in the last rate case?

A. Yes.

11. Q. Please explain.

A. The GMP employees in my department were told that costs had to be reduced so that there would be no rate increase, after initial calculations showed the need for a rate increase in the one to 2.5 percent range. There was considerable pressure exerted to find ways to reduce or defer costs in the rate year, most of which was in 2015.

12. Q. Would GMP's new rates have been lower if there was no net metered generation?

A. Yes.

13. Q. Please quantify that rate reduction and explain how it's calculated.

A. I estimated the rate impact of net metered generation based on the revenue reduction due to lower energy sales and payment of the solar premium minus the reduction in power costs resulting from the net metered generation. I estimate that the current GMP rates would have been 0.2 to 0.8% lower if there were no net metered generation on the GMP system.

14. Q. This is a wide range of results. Why could you not provide a more precise estimate?

A. Time was extremely limited due to deadlines imposed by the Board. Also, data on installed net metering capacity was limited.

15. Q. Can you provide expected rate increases in other years?

A. Yes. I calculated rate increases on a very rough basis, assuming a continuation of the current high rate of growth in net metered solar generation. The expected cumulative rate increase through 2017 is in the range of 2.0 to 3.0%, depending on the net metered solar capacity growth rate assumed.

16. Q. Please provide a simple example to show how net metering causes rate increases.

A. Assume a 100 kilowatt solar project, generating 120,000 kWh annually, which replaces 100% of a single customer's load. At the GMP energy rate of 15 cents/kWh the customer had been paying GMP $18,000 annually. This revenue compensates GMP for fixed costs that include infrastructure costs, as well as for variable energy costs.

After installing the solar project, the GMP loses the $18,000 the customer had been paying and also pays the customer a solar credit of $7,200 a year (120,000 kilowatt-hours times 6 cents/kWh). The solar generation does reduce GMP's fixed costs, but not by $18,000. A large part of GMP's costs remain after the solar generation facility is operating. It is reasonable to assume that a third of this cost remains after installation of the solar project. GMP continues to have to support its electric system and pay other fixed costs such as salaries. GMP's $18,000 revenue loss and resultant expense decrease of $12,000 results in a net loss of $6,000. Adding the $7,200 payment results in a reduction in net income to GMP of $13,200 for the 100 kW of net metered generation on an annual basis. The net cost per kWh of solar generation is $132 per year. The above example is representative of the cost impacts, and I expect the actual per kW value to be higher.

If one multiplies this rate times the total installed solar generation, one can calculate the annual total net cost impact caused by net metered generation. Dividing the annual total net cost impact by total kWh sales results in a solar net metered generation cost impact in terms of cents per kWh. Dividing the solar net metered generation cost impact per kWh cost impact by existing rates results in a per cent increase in rates.

17. Q. How did you determine the value of one third for the ratio of fixed costs not avoided by installation of net metered generation to total utility revenue requirements?

A. I did not have sufficient time to calculate a more precise ratio. However, I know from my utility experience that one third is lower than the value that would be determined with a rigorous analysis. Also, this value results in simple calculations in an illustrative example. I also performed a simplified analysis that showed a value closer to 40%.

18. Q. Would your statement that net metering in Vermont causes rate increases change if more time and information were available to precisely calculate rate impacts?

A. No.

19. Q. Has there been sufficient solar generation installed in Vermont such that the law of diminishing returns from solar induced peak shifting has occurred?

A. Yes.

20. Q. Please explain.

A. The Department of Public Service ("DPS") prepared a report entitled " Evaluation of Net Metering in Vermont Conducted Pursuant to Act 99 of 2014" which was issued on October 1, 2014 and revised November 7, 2014. In that report the DPS calculated values for assumptions of net metered generators' performance during peak times. These assumptions were used to calculate values of avoided generation capacity and transmission costs. For example, in calculating the value of avoided Regional Network Service ("RNS") transmission costs due to a fixed solar PV system with a nameplate capacity of 100 kW, the system is assumed to reduce capacity costs by the same amount as a system that can output 21 kW at all hours. A tracking solar project was assumed to output 23 kW. The SSE project is a fixed array so I will make comparisons using the fixed array values. RNS costs financially support the New England transmission grid.

RNS transmission costs are by far the largest component of GMP's transmission costs. RNS costs have been increasing in recent years at very high rates and often exceed costs of generation capacity. In GMP's last rate case, purchased transmission costs increased by about $7.4 million (8.6 percent), due to higher RNS transmission costs.

RNS costs are based on the GMP load at the time of the monthly Vermont transmission peak in all months of the year. The value of solar net metered generation is thus based on the amount of energy generated during the hour of each month in which the Vermont load peaks. Using a simple example, if a 100 kW solar project generates 50 kW at the time of the peak hourly load in six months, and zero energy in the peak hourly load for the other six months, the effective value in reducing RNS transmission costs would be 25 kW. This compares to the value of 21 kW calculated by the DPS, from the 0.210 per unit value.

The DPS 21 kW value was based on the average of data from 2003 to June of 2014. Until 2013, there was not a significant amount of solar generation in Vermont. Thus, the Vermont peaks after 2013 did not reflect the impact of new solar generation on the time of the monthly peaks. Also, solar generation capacity is growing rapidly in Vermont. Solar net metered generation capacity additions increased annually by 50% from 2012 to 2013 and by roughly 75% from 2013 to 2014. The larger solar projects selling under the SPEED program also experienced high growth rates starting in 2013. By averaging data that contained no or little peak shifting impacts for 11 years of the 12 years resulted in an overvaluing of the solar net metered generation for reducing RNS transmission costs.

I obtained monthly Vermont peak data from the ISO-New England public web site for the most recent 12 month period ending March 2015. I input that data in the spreadsheet model used by the DPS to calculate its 21 kW value. The result was a 6.4 kW value (per unit factor of 0.0642), which on a comparable basis would result in a 100 kW fixed solar project having an average value of 6.4 kW. This is almost a 70% reduction in RNS transmission capacity value from that calculated by the DPS.

The 6.4 kW value is so low because the most recent 12 month period reflects the effect of the solar induced peak shift. In the recent 12 month period the Vermont peaks occured after sunset in eight of the 12 months. Thus the solar generation value was zero in those months. In the month of July when New England peaked, the expected solar generation is 55 kW. It is notable that in August of 2014, the Vermont peak hourly load occurred at the 6 to 7 PM period, when the DPS data showed that the fixed solar generation had expected generation of 9 kW. Thus, the new SSE project will reduce the high cost RNS transmission costs of GMP by effectively only 6.4% of its installed nameplate capacity!

The peak shift phenomenon is now widely accepted by ISO-New England, VELCO and GMP. It is expected to move the annual summer peaks to later periods, which will reduce the generation capacity value of solar. Southern California in particular has experienced problems with solar induced peak shifting.

21. Q. Is the current practice of the DPS and Board consistent with past practice, regarding consideration of economic impact when approving of solar projects?

A. No.

22. Q. Please explain.

A. In the 1990s both CVPS and GMP were severely penalized in a “prudency” proceeding before the Board. In regulatory context, prudency refers to the expected behavior of utilities in the course of making decisions affecting their future costs. A utility is expected to be prudent and purchase the lowest cost power source. Both CVPS and GMP had executed in 1989 a new contract with Hydro Quebec (“HQ”), based on assumptions of future costs of generation plant construction and natural gas fuel. An unexpected event that occurred after this contract was executed allowed the Vermont utilities the option of cancelling the HQ contract. Allegedly CVPS and GMP had newer information at that time the HQ contract when could have been voided. The DPS argued before the Board that CVPS and GMP were “imprudent” by not voiding the HQ contract when they would have known about the new, lower cost purchase options. Knowing that lower cost alternatives existed, CVPS and GMP coud have purchased the lower cost sources. The DPS alledged that a prudent utility should always consider all its options to purchase power from the lowest cost sources to keep rates lower.

The alternative power sources were from older oil and gas fueled existing generating units. At the time there were no renewable energy requirements, so the renewable attribute of the HQ contract did not add value. The Board ruled that since both CVPS and GMP did not prudently purchase the lower cost sources and imposed severe penalties.

CVPS and GMP executed a new contract with HQ to replace most of the old HQ contract. The new HQ contract purchases energy priced essentially at the New England wholesale market price, which is lower than that of the price that GMP customers effectively pay for energy purchased from net metered generation. There are new transmission links being planned to deliver additional HQ power to Vermont and other parts of New England. It is quite possible that energy from a new HQ contract, even if priced above that of the new HQ contract, would be lower than that supplied by net metered generation. HQ continues to build new hydro-electric facilities, and can also purchase from other Canadian hydro-electric plants. Thus, HQ could provide renewable energy at a lower cost than the effective cost of solar net metered generation. The reliability of the new HQ power would be comparable and probably better than that provided by solar net metered generation.

While working at GMP, I knew of no studies performed where renewable energy from a new HQ contract was considered as an alternative to obtaining renewable energy from net metered generation. Under DPS and PSB precedent set in the 1990s, there would be a Board proceeding to determine if GMP acted prudently by not considering additional Hydro Quebec energy purchases as an alternative to energy provided by net metered solar generation facilities.

23. Please describe the impact on system reliability of the proposed solar electric generation facility.

A. Since the SSE project is larger than 150 kW, the SSE developer must commission a System Impact Study that addresses the impact on system reliability of the SSE generation facility. I have not had time to even verify that such a study was done. Sometimes a System Impact Study will require that changes be made on the electric system or generation project to maintain reliability. I cannot comment on any of these matters.

I can comment on the impact of solar net metered generation in general. The SSE project by itself will not impact system reliability, if one assumes that all conditions mandated by the System Impact Study, if any, are met. However, if one lumps the SSE project with other net metered projects, both in existence now and those expected to be installed in the near future, there is a negative impact on reliability. The negative impact is difficult to prove in specific terms. Rather, it is an indirect impact of the financial pressure caused by the economic impact of solar net metered generation. The negative reliability impact occurs after a certain amount of solar net metered generation capacity is installed and electric rates are constant. I cannot quantify the capacity limit but can speak in qualitative terms.

Utilities are almost always pressured to keep rates constant or minimize increases. Rate increases are extremely unpopular. Additional solar net metered generation results in less cash for GMP to rebuild and maintain its system. That GMP decided to commission a new depreciation study that lowered depreciation expense prior to filing its last rate case helped in meeting its zero rate increase goal. However, it resulted in $5 million a year revenue reduction. The purpose of depreciation is to provide cash to rebuild utility infrastructure.

Another impact of solar net metered generation occurs when a substantial amount of solar generation, net metered or otherwise, is installed on the GMP distribution system. As more solar generation is added, power flows begin to reverse at certain times. Also, there may be overloads or voltage drops on parts of the system where the local system/circuit is weak. I can illustrate this using a simple, extreme example. Suppose a distribution circuit where solar generation is installed that meets all the annual energy load of that circuit. The load has a 5 MW peak and annual energy is based on an annual load factor of 60%. The solar generation has an annual capacity factor of 15%. Thus, to provide the same energy, the solar capacity must be four times higher than the load peak. This is because the load factor (here this factor is effectively the same as capacity factor) is four times higher than the solar capacity factor. Without explaining the details of the math, the solar capacity must be 20 MW to provide all of the distribution circuit load.

In this extreme case, when solar output is at its maximum, the power will flow in the reverse direction, from the customers back to GMP. The circuit load at the substation would be 15 MW (20 MW less 5 MW delivered to customers on the circuit). This would most likely require expensive upgrades of the substation.

24. Does this conclude your testimony?

A. Yes.