Comments on the Massachusetts Alternative Portfolio Standard Regulations (225 CMR 16.00)

Submitted by: Richard Bonte
President Sun Source Energy Products
432 Sand Shore Road Unit 5
Hackettstown, NJ 07840
rbonte@sunsourceproducts.com

1. These comments are to address section 16.05 (4) (b) Small Generation Unit Annual Net Useful Thermal Energy Determination

    a. Section 16.05 (4) (b) addresses the waiver of metering requirements for Small Generation Solar Thermal Energy systems which are defined in the publication dated June 8, 2016 entitled *Guideline on Metering and Calculating the Useful Thermal Output of Eligible Renewable Thermal Generation Units.*
    b. Table 1 of the above mentioned document defines a small solar energy system as a system with a total plate surface area of less than 660 square feet. Systems of this size do not require metering to determine the number of Alternative Energy Credits (AECs) a specific system will earn.
    c. Section 3 D) (1) states that the AECs from Small Solar Thermal RTGUs, both domestic hot water systems and combined domestic hot water and space heating systems are calculated by using the annual energy estimate provided by the Solar Rating and Certification Corporation (SRCC) OG-100 Solar Collector Rating (or equivalent entity). The calculation of AECs is based on the SRCC OG-100 Solar Collector Rating for Category D, Mildly Cloudy, and Medium Radiation.
    d. It is my belief that criteria for requiring the use of Category D are inappropriate for Solar Domestic Water Heating in a climate such as the Commonwealth of Massachusetts and that the criteria should be revised to state Category C. The decision to require Category D were based upon an interim report titled Commonwealth Solar Hot Water Program Residential Performance Monitoring published June 1, 2012 by Beam Energy and Engineering which contained flawed data and installation practices leading to an interim conclusion that was based upon flawed data and assumptions.

2. The category ratings issue:

    a. In June of 2012 the Massachusetts CEC changed the criteria for determining rebate amounts based upon a report prepared by Beam Energy and Engineering. Previously, the rebate level awarded the customer was based upon a calculation using the number of BTU's generated by a solar thermal collector at the SRCC OG-100 rating level of category C.
    b. The Beam Energy and Engineering report referenced above monitored 40 solar hot water systems, 35 of them with a reporting system manufactured by Sun Reports. Many professionals in the solar thermal industry were aware of the shortcomings of the Sun Reports system, and in fact our company made a determination to stop selling the product that year and ceased all sales and returned remaining product to the vendor during 2012 due to monitoring irregularities.
    c. Of these 40 monitored systems, 2 were not working. Of the remaining monitored systems 27 were flat plate and 11 were evacuated tube. The Beam Report stated that monitored production of the systems was between 26% and 134% of what was expected overall. It was reported that numerous systems had equipment malfunctions and poor equipment installation

including poor location of sensors and flow meters. Of the systems that did not have installation or equipment issues the reporting was between 80% and 110% of what was expected. Although the Beam Report indicated a lack of confidence regarding the accuracy of the data that was collected, the report reached the conclusion that the use of Category C mildly cloudy to determine collector production overestimated expected production by 63%. This resulted in an interim recommendation to change the criteria for estimating collector production from Category C mildly cloudy to Category D mildly cloudy. The Massachusetts CEC concurred in this recommendation and changed the rating criteria as suggested by the Beam report.

d. When the final report was issued in early 2016 no discussion of this previous interim recommendation was made and the program continued at the Category D rating level. It is clear from reading the interim report that there were serious questions regarding the quality of the data and that these were not addressed in the final report. Therefore a recommendation was made on data that was not sufficient, and the program has continued to suffer from this decision. The result of the decision has given higher rebate amounts to systems which utilize evacuated tube collectors versus flat plate collectors even though the annual production from each type of system is virtually identical. It will be shown in later comments that on an annual basis evacuated tubes and flat plate collectors perform within 1% of each other when utilized for solar water heating.

3. What do the rating levels mean:

   a. In the late 1970's the SRCC established a rating standard for solar thermal collectors known as OG-100. The ratings are based upon daylong BTU output performance of a solar thermal collector based upon gross collector area for specific purposes which are defined as category ratings A through E. The categories are defined by the temperature difference between the average solar collector temperature (defined as the average between the solar collector temperature inlet and outlet) and the outdoor ambient air temperature. The specified ranges by the SRCC are:

      Category A (-9F) Solar pool heating in a warm climate (solar collector temperature 9 degrees cooler than ambient air temperature)
      Category B (+9F) Solar pool heating (solar collector temperature 9 degrees warmer than ambient air temperature)
      Category C (+36F) Solar water heating (warm climate) (solar collector temperature 36 degrees warmer than ambient air temperature)
      Category D (+90F) Solar water heating (cool climate) (solar collector temperature 90 degrees warmer than ambient air temperature)
      Category E (+144F) Air conditioning/Industrial Process heat (solar collector temperature 144 degrees warmer than ambient air temperature)

   b. Solar collector temperatures vary throughout each day and throughout the year based upon storage tank temperature, ambient air temperature, wind speed and solar radiation. It is a constantly moving target; however some general rules do apply. Most mornings the bottom of the solar storage tank will be approximately 55F. In a properly operating domestic water heating system the average solar collector temperature will be about 15F higher than the storage tank temperature at any given moment throughout the day. When systems begin operating in the morning solar collector temperatures will be quite low so that there will actually be times during the May through September time period that the systems will

actually start operating when the collector temperature is in the category B range. As the day progresses collectors will move into the category C range and on occasion during the severest winter months will operate in the category D range for a portion of the day. The highest collector temperatures are usually reached at about 2:30 PM in the winter months and about 4:30 PM during the summer months which coincides with the time or maximum ambient air temperature each day.

4. The temperature criteria for Massachusetts:

    a. For the Commonwealth of Massachusetts the NOAA has three reporting stations for climate data. Shown below are the average daytime high temperatures for the three stations:

Month	Boston	Springfield	Worcester
January	36	36	31
February	39	39	34
March	46	48	43
April	56	61	54
May	67	72	66
June	77	81	74
July	82	85	79
August	80	84	77
September	73	76	69
October	62	65	58
November	52	53	47
December	42	39	36

    b. Typical solar collector temperatures during the day by season will usually range as follows:

Winter:	Starting temperature	65F	End of day temperature	125F	Average 95F
Spring:		65F		140F	103F
Summer:		65F		160F	112F
Fall:		65F		145F	105F

From this data it can be seen that for a major portion of the year solar collector temperatures are in the Category C range (36 degrees higher than the ambient air temperature) and that the use of Category D to determine average annual solar collector production is underrating the actual production of the solar collectors by basically stating that every day of the year is as cold as a very cold January day, which of course is not true. It should be noted that the State of New Hampshire which has a more severe climate than Massachusetts uses Category C for rebate calculations. The State of New York uses either OG-300 or Polysun or other equivalent simulation document for rebate calculation.

5. Annual ratings:

    a. Although the category rating levels are a good way to evaluate performance of one collector relative to another, the SRCC recognized that there were shortcomings in using these levels to predict annual performance at a given location and climate. In the early 1980's the SRCC developed a standard known as OG-300 which modeled the system performance of a solar water heater based upon annual usage, climate and the number and types of solar collectors. Manufacturer's have spent considerable amounts of money to have their

systems tested and rated by the SRCC, and it is generally recognized in the industry that these ratings are a much more accurate predictor of performance of a solar hot water system at a given location on an annual basis.

b. In addition to the annual ratings that the SRCC has given to various systems submitted for testing, there are available today a number of software packages that allow the solar professional to build a system with collectors, storage tanks and controls and model that configuration for a given location and climate to accurately predict the performance of the system. Some of these are known as Polysun, F-chart and others and are widely recognized for their accuracy in predicting energy delivered by the system.

c. The use of annual ratings for solar water heating systems is the most preferential method of determining annual performance whether it is an OG-300 rating or a third party software package. The drawback is that there may be configurations of panel size and tank size that an installer may want to install for which there will not be an OG-300 rating. Additionally, many small installers may not be able to afford or do not possess the skills to utilize a third party software package.

6. Common types of solar collectors:

   a. The three most commonly installed types of solar collectors in the Massachusetts are:

      Evacuated tube collectors – These collectors insulate the absorber plate in a vacuum and are very suitable for high temperature applications. They outperform all other collectors for space heating applications. They generally outperform all other collectors when the collector temperature is 50F warmer than the surrounding outside ambient temperature. They perform best at the upper end of Category D and the upper end of Category C.

      Glazed flat plate collectors – These collectors are the mainstay of the solar hot water industry. They are very cost effective and suitable for solar water heating applications and indoor year round solar pool heating applications. They perform best at Category B and Category C to the lower end of the Category D level.

      Unglazed flat plate collectors – These collectors are used extensively for summer solar pool heating applications and are extremely cost effective. At Category A and Category B they will outperform evacuated tube and glazed flat plate collectors, so they are well suited for the Massachusetts climate for the period from May through September for pool heating. They typically install at 1/5 the cost of similar sized glazed systems. They do have reduced performance at the category C range.

   b. The current Category D range criteria drives the consumer to consider evacuated tube collectors over glazed flat plate collectors for solar water heating due to the higher rebate that is awarded even though annual numbers to be shown later show virtually no difference in annual production for solar water heating in Massachusetts.

c. Shown below are the current CEC rebate calculations for two popular systems presently being installed in Massachusetts. The two systems are comparable in size and annual production.

Flat Plate	Evacuated Tube
2 SunEarth model EC-40 solar collectors	2 Apricus AP-30
1 120 gallon storage tank	1 120 gallon storage tank
Pumped closed loop	Pumped closed loop
SRCC OG-300 system 2001001N modified for Boston	SRCC OG-300 system 2011078B modified for Boston
Annual savings 4490 Kwhr (15,324Kbtu)	Annual savings 4500 Kwhr (15,358Kbtu)
SRCC OG-100 rating	SRCC OG-100 rating
Category C mildly cloudy = 30.7Kbtu	Category C mildly cloudy = 29.3 Kbtu
Category D mildly cloudy = 16.5Kbtu	Category D mildly cloudy = 23.0 Kbtu

CURRENT METHOD OF REBATE CALCULATION

Flat Plate	Evacuated Tube
Based upon SRCC OG-100 Category D mildly cloudy	
16.5 Kbtu X 2 panels X $100 = $3300	**23.0 Kbtu X 2 panels X $100 = $4600**
Based on SRCC OG-300 annual ratings	
15,324 Kbtu X $0.17 = $2605	**15,358 Kbtu X $0.17 = $2610**

d. Two contradictions should be evident from the above table. The annual production based upon SRCC OG-300 shows that both systems are identical in annual performance in the climate of Boston, MA. This is evident from the annual predicted savings of 4490 Kwhr and 4500 Kwhr. However the OG-100 Category D rebate levels are widely apart, $3300 for glazed flat plates versus $4600 for evacuated tubes. This is a 40% rebate advantage for evacuated tube collectors even though the annual production is identical for each system. Using the Category D level for determining the rebate is rating the annual performance of the system on the coldest period of the year. Although evacuated tube collectors will outperform glazed flat plate collectors in January, flat plate collectors will outperform evacuated tubes in July. The net result on an annual basis is virtually identical performance.

e. The other contradiction is that if one uses the OG-300 method of rebate calculation as authorized by the Massachusetts CEC, the rebate levels will be virtually identical, HOWEVER substantially lower than using the Category D OG-100 rating calculation. Both of these disparities need to be corrected so that the rebate levels for identically performing systems are consistent and that the methods of calculation whether OG-100 or OG-300 yield the same rebate results to the customer.

f. Since the proposed system of computing the AECs under the proposed APS regulations is tied to the same criteria as the Massachusetts CEC program, that is Category D ratings for computing AECs, the same disparity will continue, either short changing the consumer on his rebate amount or driving the market towards one type of collector over another without any scientific basis.

7. Solar pool heating:

a. Although not specifically addressed in the proposed APS regulations or the current Massachusetts CEC program, swimming pool heating is a considerable market in the Commonwealth and a substantial contributor of fossil fuel emissions. The use of unglazed

solar collectors for this application allows for 60 to 100% reduction in the use of fossil fuels for the heating of residential and commercial outdoor pools. The low cost for these systems, usually about 20% of a solar water heating system on a per square foot basis, allows for rapid payback of these systems, usually in three years or less and a substantial reduction of the use of fossil fuels and the generation of greenhouse gas emissions.

b. The current rebate criteria using category D for determining the rebate amount precludes the inclusion of these types of systems for any incentive, since there are no unglazed flat plate collectors with a BTU rating at category D. However many unglazed flat plate collectors do have ratings at Category C, which would allow a small rebate for the consumer. In fact, since most of these systems operate only in the summer months, they actually perform at the Category B rating level.
c. A typical 18' X 36' outdoor swimming pool in Needham, Massachusetts will require about 105,000 Kbtu annually to keep the pool temperature in the low 80's during the swimming season from mid May to late September. A 480 square foot solar pool heating system will provide 65% of that energy, reducing the requirement for natural gas by about 682 therms assuming a pool heater efficiency of 90%. This translates into a reduction of 10,436 pounds of CO2 emissions. Since the major purpose of the APS is to reduce fossil fuel usage and their subsequent emissions, then the reduction of energy consumed heating residential and commercial swimming pools should be strongly encouraged. **In many cases four months of residential pool heating with natural gas will add almost five times the amount of emissions to the atmosphere than twelve months of domestic water heating with the same fuel**.

8. Summary:

   Based upon the above comments I suggest the following changes to the Massachusetts Alternative Portfolio Standard Regulations (225 CMR 16.00) and more specifically section 16.05 (4) (b) Small Generation Unit Annual Net Useful Thermal Energy Determination

   a. Change the rating category for determining both the CEC rebate and the awarding of AECs from Category D to Category C. This is based upon the data presented above and the fact that two neighboring states with similar or more severe climate criteria use a more equitable method of calculating rebates.
   b. Add solar thermal pool heating for both year round and seasonal indoor and outdoor pools to the portfolio. For outdoor pools which are seasonal in their operation (usually mid May through September) consider using Category B for unglazed solar thermal collectors and determine the rebate based upon 120 days of operation.

9. Personal background:

   a. Education – Newark College of Engineering, Newark, NJ (BSIE 1970)
   b. NABCEP solar thermal certificate ST031409-2
   c. Solar thermal installer 1977 through 2013 (over 2000 systems)
   d. Solar thermal wholesaler 2005 to present