July 11, 2017

Avid Solar[1] appreciates the opportunity to submit comments regarding 225 CMR 20:00 Solar Massachusetts Renewable Target (SMART) Program. Avid Solar understands that the SMART program emergency regulations have been introduced to achieve multiple goals, including:

(a) Sustaining the local Massachusetts solar economy through the next 1600 MW of solar development, recognizing that this local industry has been an engine for economic growth in the Commonwealth since the Great Recession and that it has created thousands of well-paid jobs;

(b) Helping Massachusetts achieve its ambitious Global Warming Solutions Act commitments, while also benefitting the state economy through local construction activity in the near-term, as well as long-term reductions in energy and fossil fuel imports, allowing the state to reinvest more in its own economy;

(c) Ensuring access to the benefits of locally generated solar power, for as many people as possible, through a diverse portfolio of solar installation types, while also stimulating the use of under-utilized real-estate for development; and

(d) Lowering the cost to ratepayers for the benefits of local, solar-powered electricity generation;

(e) Engaging market forces to enable price discovery, respond to changing technology costs, and help eliminate any incentives that may be required to stimulate solar development to the extent that its development costs exceed solar's benefits to the grid and the citizens for Massachusetts.

It is not easy to address these goals simultaneously, and SMART achieves some better than others. In the spirit of trying to offer constructive opportunities for improvement, Avid Solar has invested significant time analyzing not only the potential impact of the SMART program as proposed, but also the surveys, reports, analyses and data that were used by DOER to inform its decision making regarding the design and incentive levels of SMART. Given Avid's recent focus on the ≤ 25 kW market segment[2], our comments will primarily address this segment which we know well. Some of the recommendations, however, can also apply to other segments.

Summary of Avid Solar's Findings

Avid Solar discovered that due to a combination of factors, the SMART program assumes an economic and financial understanding of the Residential market segment—and the ≤ 25 kW capacity segment, generally—that is significantly different than what recent data and experience demonstrates. If not corrected, DOER

[1] Avid Solar LLC is a small business based in Holden, MA. The company focuses on the residential and small commercial market segment, primarily around Central Massachusetts. The company was founded in Massachusetts in 2012.

[2] Since March 2015, there has been a Net Metering Cap in place nearly continuously in National Grid territory, making it inaccessible for commercial solar development for small and medium businesses. The NM cap raise in the spring of 2016, once placed into effect, did not even clear the MassACA waiting list at that time for National Grid customers.

may accidentally cause serious harm to this market sector and the businesses that serve it. There are 7 key factors that need either adjustment or further consideration in the program design:

1. The $/Wdc installation costs assumed by Sustainable Energy Advantage (SEA) are significantly lower than the best, recent Massachusetts data demonstrate;
2. Within the < 25 kW Capacity segment, there is a wide range in the $/W installation cost, due primarily to scale, making the incentive level either too high for systems in the upper end of the range, or too low for smaller systems, causing inequity within this segment;
3. The Capacity Factor (i.e., the expected annual kWh generation per kWdc of capacity) for the < 25 kW capacity segment is too high based on actual recent production data;
4. The Target Return on After-Tax Equity (also represented at times by the "Target IRR%", "Revenue Requirement", or simple cash "Payback") is significantly lower than it should be for host-owned systems, especially host-owned systems in the < 25 kW segment, resulting in SEA's modeling a significantly understated "Revenue Requirement", which contributed to DOER establishing an inadequate incentive level;
5. Residential customers in the < 25 kW segment cannot claim depreciation expense tax benefits, putting them at a disadvantage relative to commercial projects otherwise earning the same incentives for identical projects, including third-party ownership companies serving the residential marketplace. After all federal and state tax benefits are considered, an adjustment in the incentive level should be made to put residential owners on an equal footing;
6. The projected rate of PV system cost decline in the < 25 kW system is not supported by recent experience, even though PV technology costs have been decreasing. This is largely due to the high fixed- and semi-fixed overhead costs associated with any size of small PV project in Massachusetts, as well as the relatively higher labor costs;
7. Interest rates, especially for the Mass Solar Loan program, are increasing, raising the monthly payment costs of investing in solar. The rate increases are making it harder to create "monthly cash-flow positive" PV solutions, and it could be impossible under the proposed SMART incentive levels.

1. Installation Cost Assumptions 18% Too Low in the < 25 kW Capacity Segment

In Sustainable Energy Advantage's report, "Developing a Post-1,600 MW Solar Incentive Program: Evaluating Needed Incentive Levels and Potential Policy Alternatives", many of the assumptions used in their modeling exercises were made explicit, and the data sources were generally noted. In Table 15, the modeled Base Cost for a 7 kWdc Residential System, used to represent the average residential solar system, was $3,675 per kWdc. The source of this data was a relatively small sample size from the Participant Survey that preceded the modeling exercise. Noting the potential risk of self-reporting bias, they further modified the results of those survey responses to arrive at their base case costs.

A much better data source is the Mass Solar Loan (MSL) program which contains the turnkey, contracted price between a willing installer and buyer in a very competitive market. Through a public records request, the MSL program provided data on over 2,000 such transactions since the program began in late December 2015. This data set provides not only a better average system size and price for the residential market, but also for various capacity sizes within the ≤ 25 kW market segment. The following Table 1 notes the total count and $/W average for systems in the 0 – 6 kW(dc), 6 – 10 kW(dc), and 10+ kW(dc) subsegments.

Table 1			
DC Capacity Size:	0 – 6 kW(dc)	6 – 10 kW(dc)	10 – 25 kW(dc)
Average $ / Watt (dc):	$4.53	$4.19	$3.85
% More than 10 – 25 kW	*18%*	*9%*	*0%*
Count:	521	1,176	599
Total kW(dc)	2,508	9,409	7,150

The Mass Solar Loan data through June 2017 of completed systems shows that even in the larger 10+ kW(dc) segment, the average installed system costs for residential PV systems in Massachusetts are higher than what was modeled by SEA for a 7 kW(dc) system. For systems in the 6 to 8 kW(dc) range, the average cost was $4.34/W(dc), or about 18% more than the modeled 7 kW(dc) system used to represent the average residential system. ***By using a significantly lower installed system cost assumption for the typical residential PV system, SEA and DOER would have underestimated the "Revenue Requirement" significantly, resulting in a lower incentive design under the SMART program.***

2. Installed Cost Variation Within the ≤ 25 kW Capacity Segment Needs to Be Considered

What also becomes apparent when analyzing the $/W installed system costs reported to the MSL program, is the significant economies of scale within the 0 – 25 kW segment. The sub-segments in Table 1 (0-6, 6-10, 10+) approximate the lower quartile, the 2 middle quartiles, and the upper quartile, respectively. They are also grouped around the most common AC inverter sizes: 3.8 kW, 7.6 kW and 10+ kW. Relative to the incentive required to support the 10+ kW segment, it suggests that, based on installed system size cost alone, the compensation for the 0-6 kW(dc) systems should be roughly 20% higher, and for the 6-10 kW(dc) systems, the compensation should be about 10% higher in order to achieve the same targeted rate of return regardless of system size. Alternatively, the 10+ segment could be 10% lower than the 6-10 kW segment, while the 0-6 kW segment is 10% higher than the middle quartiles. Another approach would be to have a base adder incentive that steps down based on system size (e.g., $0.10 - $0.01/W(ac)).[3] ***To achieve equity within the < 25 kW segment, due to the economies of scale due to system sizes, the incentive should be adjusted by system size in some manner.***[4]

[3] The actual "incentive" level difference (vs. compensation level difference) required to create a level playing field based on system size depends on additional factors. As a follow-up to this analysis, if requested by DOER, Avid Solar can suggest an overall incentive scheme that takes several combined factors into consideration. Avid Solar believes that the adjustments to compensation for the ≤ 25 kW segment should largely be accomplished by non-declining adders instead of trying to adjust the index multiplier.

[4] The same price variation, of a nearly equal magnitude difference, exists in the 25 -250 kW(dc) capacity market segment. A similar solution to either lower the incentive at the upper end of the segment, or raise the incentive for smaller systems should be considered and implemented on both an equity basis, and to ensure ratepayer funds are not being wasted.

3. Modeled Capacity Factor Too High for the $\leq$ 25 kW Capacity Segment

Avid Solar looked at two data sources for Massachusetts PV systems to calculate the realized capacity factor[5] (an expression of the kWh/kW generated annually by a PV system). MassCEC PTS generates a report of the realized AC energy generation reported for the purposes of earning SRECs. The most recent report included data from 2010-2015 for all systems participating in the Solar Carve Out RPS programs (aka SREC I and SREC II). Only systems with 12 months of reported generation in the calendar year are included in the PTS report on the annual capacity factors achieved. Unfortunately, due to a very snowy February 2015, many systems that otherwise reported monthly data for all of 2015 were excluded from the report for 2015. Avid Solar believes this was not handled correctly; we believe those systems should have been included in the report with a reported generation value of 0 kWh for February. For the years 2010 through 2014, we segmented the data set by DC capacity and calculated the capacity-weighted capacity factors. We also looked at the average across all years (2010-2014).

Avid Solar also requested the modeled annual AC kWh production that is calculated by the Mass Solar Loan program, taking into consideration inverter efficiency, the tilt and azimuth of the panels, roof- or ground-mounting of systems, and annual shading of the PV modules. It is a high-quality estimate using a consistent algorithm, utilizing PVWatts.

Table 2				
Year(s)	**0-25 kW(dc)**	**25-250 kW(dc)**	**250-500 kW(dc)**	**500+ kW(dc)**
PTS 2010-2014	13.2%	13.0%	13.0%	13.9%
PTS 2010	13.2%	13.2%	13.3%	14.0%
PTS 2011	12.8%	12.5%	12.7%	12.4%
PTS 2012	13.6%	13.5%	13.3%	13.9%
PTS 2013	13.3%	13.1%	13.2%	14.2%
PTS 2014	13.1%	12.7%	12.9%	13.8%
MSL 2016-2017	13.0%			
MSL 2016	13.0%			
MSL 2017	12.9%			

Both the reported data from PTS and the modeled data from MSL, noted in Table 2 above, demonstrate that a 13.0% capacity factor is the best assumption to use for the average 0 – 25 kW(dc) system in Massachusetts. In fact, it is generally the correct Capacity Factor assumption to use for all systems except for those over 500 kW(dc) in capacity. These larger systems tend to be solar farms that are ideally situated to generate as much solar power as possible, and they achieve an average capacity factor of 14%. Given that the overall installed capacity of the Over 500 kW(dc) segment is larger than all of the smaller segments combined, it pulls the overall average capacity factor for the state much higher than 13.0%, but for the purposes of estimating the expected generation of systems under 500 kW(dc), a 23% Capacity Factor is more appropriate.

SEA used a 13.48% Capacity Factor for the < 25 kW segment, overestimating the annual generation by nearly 4% compared to a 13.0% Capacity Factor derived from the best, recent MA data available. Again,

[5] Capacity Factor % = (AC kWh generated) / [(kW(dc) PV Capacity) x 365 days x 24 hours]

this results in an underestimate of the "Required Revenue" or compensation level required to achieve the Target IRR of investors in the 0 – 25 kW capacity segment.

4. The Required Rate of Return Used to Model the Host-Owned Required Revenue Is Much Too Low

SEA used a base "Target After-Tax IRR" of only 5% for Host-Owned Systems Under 25 kW (see Figure 17) in their modeling of the Revenue Requirement. No basis for this assumption was provided in the Post-1600 MW report, nor through follow-up questions with SEA. The target IRR does not reflect the industry input from the Participant Survey, perhaps due to a small sample size. Looking back at the Net Metering and Solar Task Force Final Report, the only mention of a 5% discount rate was when SEA discounted future ratepayer benefits achieved through solar, but that is not an appropriate rate to use for a solar equity investor.

Many people, even within the solar industry, misunderstand the appropriate discount rate to use when discounting the potential future solar benefits for an equity investor. SEA makes several mistakes concerning the appropriate discount rates to use for various segments of the market. Fundamentally, a discount rate that is used to estimate the present value of future cash flows is based on the perceived riskiness (uncertainty) of those projected cash flows and the time value of money (i.e., an inflation adjustment).

Nearly all people buying a PV system to offset their own energy generation (i.e., "Host Owners"), are buying a system for the first time, and they have likely had no prior experience with and have a very limited understanding of PV technology, PV system performance, incentives, tax benefits, PV resale values, maintenance costs and requirements, insurance costs, utility tariffs and regulatory risks. They also probably have no prior relationship with the PV contractor installing their system. Additionally, the size of the investment is one of the most expensive "home improvements" most have every made. There is significant risk perceived by them, and many are probably underestimating some of the risks involved (e.g., utility tariff risk, because their installers are not informing them).

Suggesting that these potential host owners consider the risk of investing equity in a PV system to be only slightly riskier than investing in a high-grade (A or better) 20-yr corporate bond (recently around 4.5%) is ludicrous. Similarly, suggesting that a commercial host owner would use their Weighted-Average Cost (WACC) of Capital for capital investments in their business is also a mistaken assumption. PV system investments are not typical capital investments for those businesses, whose WACC is predicated on typical capital investments for their industry, not investments in PV. Likewise, the nature of the equity risk of PV system investments cannot be determined by examining the typical borrowing rate (secured or unsecured) for a potential host owner. In other words, using the interest rate for a Home Equity Line of Credit, or a Mortgage with a security position in the associated real estate, or even an unsecured Credit Card rate cannot be used as proxies for the cost of equity for PV investments. Those rates are independent of the inherent uncertainty of the PV system's future cash flows, and especially the ***perceived*** risk of those cash flows to the novice PV system equity investor.

The best estimate we have for pricing the risk of PV system cash flows comes from those investors who are taking positions in a portfolio of PV PPAs or Leases. Those generally seasoned investors, often making repeated PV investments, are able to understand, model and subsequently evaluate the risks associated with PV cash flows. To the degree that there is insight into the cost of equity for third-party owned (TPO) system ownership for a market segment, it should become the basis of determining the required/target IRR for the host owner of a PV system. And, I would argue, that the host owner likely perceives a greater degree of risk than the seasoned PV investor due to their lack of experience and understanding of the actual risks involved. In other words, to the degree that SEA was able to ascertain the TPO cost of equity for a market segment, the cost of equity for the host-owner should be no lower, and potentially should be higher.

There are some differences in the TPO equity owner and the host equity owner that should be factored into their estimate cost of equity. For example, the TPO owner receives a greater degree or tax benefits because of their ability to claim depreciation expense. The counter-party to the tax benefits is the government, and there is very low risk to these benefits (there is essentially no performance risk; the PV system just needs to remain operational). Thus, due to greater tax benefits for commercial investors (even after considering the MA residential income tax credit), the commercial cost of equity is lower. The TPO investor has additional counter-party risk, however, because their future cash flows are dependent on the customer's ability and willingness to make monthly payments. This increases the risk of the TPO investor.

At the end of the day, the cost of equity (which can otherwise be expressed as the Target IRR or Required Revenue), should be at least as high for the host owner as it is for the third-party owner for various segments. SEA differentiated the Target IRR's for host-owned vs. TPO systems, and this is a serious flaw in their modeling of the required revenue requirement, and, thus, the required incentive levels of the SMART program. In the ≤ 25 kW segment, SEA modeled a lower Revenue Requirement for Host-Owned systems (see Figure 17). Instead of the base Target IRR of just under 9% used for TPO, SEA assumed a base Target IRR of only 5% for host-owned systems. Using a 25-yr annuity of equal payments as a test case, the NPV of the cash flow at 5% is nearly 46% more than the same cash flow discounted at 8.75%. For a 10-yr annuity, it is about 22% higher. In other words, by understating the cost of equity (the targeted after-tax IRR for the equity invested), the SEA revenue requirement as calculated and supplied to DOER is considerably too low for the host-owned market segment.

Finally, I will note that given our experience in the Under 25 kW market segment, and the lack of financial sophistication of the potential host-owners in this market segment, very few think about their equity investment in terms of "Target IRR" or "Required Return on Equity." Instead, they look more simply at the simple cash payback as a reasonable proxy. ***While Avid Solar believes that SEA has significantly underestimated the Effective Revenue Requirement of the ≤ 25 kW market segment because it used an unfounded, considerably-too-low cost of equity assumption, it probably makes more sense to evaluate the proposed compensation levels on whether they result in a Simple After-tax Cash Payback that meets market demands and expectations. Typically, that is around 7 years for PV systems, as many residential installers will attest.***[6]

[6] SEA was correct to suggest that a more certain value for a PV production incentive should result in a lower cost of equity for PV investments, and DOER is 'smart' to choose that option in an effort to lower the nominal cost to ratepayers of the production incentive, all else equal. Recently, however, the perceived regulatory risk of investing in PV has been increasing, caused by efforts, led by the utilities and EEA, to diminish the value of net metering credits; by utility requests to reduce the share of kWh-based charges in utility bills and/or to pursue solar-specific fixed charges in tariffs; and by EEA's resistance to pursue a study to clarify the benefits of solar distributed generation, despite the unanimous recommendation by the Net Metering and Solar Task Force to pursue such a study. Due to these multi-pronged initiatives to devalue solar distributed generation compensation, coupled with EEA's refusal to settle the matter on solar's value, it is unclear if the overall compensation value to PV investors under SMART will be perceived as much less risky than it has been recently under the solar carve out programs despite the attempt by DOER to reduce the uncertainty of the production incentive revenue stream.

5. SMART Needs to Consider Depreciation Tax Benefits in the < 25 kW Segment

According to SEA, they did not model residential host-owners as a separate segment because of a limit on the number of "Competitive Groups" they could simulate and model while generating their Post-1600 Report, but they did agree that depreciation tax benefits are a significant economic benefit for those that can claim them. For Corporate owners of PV systems with a combined federal and state marginal income tax rate of ~ 40%, it can account for a cost recovery of 34%[7] of their PV investment within the first 5.5 year. When combined with the 30% ITC, the combined cost recovery from tax benefits can be as high as 64% at extremely low risk, before having to consider the actual performance of the PV system or the expected regulatory risk of any cost savings. PV host-owners, if they have the income required to offset the income tax credit, receive only 30% back in federal tax benefits and a maximum $1,000 in state income tax benefits for their primary residence. Before even considering performance risk or utility tariffs, commercial owners[8] of PV systems in the ≤ 25 kW segment have a better financial proposition, lower risk, and significantly faster cost recovery (i.e., payback) for an investment in an identical PV system.

Offsetting the inherent depreciation tax savings available only to commercial owners, business must also pay a tax on the energy savings realized by BTM PV systems or on the income stream derived from payments made by host customers. While this tax on their increase in income due to the PV investment increases their tax liability, commercial owners still enjoy a faster after-tax payback on their investment when both accelerated depreciation and the tax on their PV income are taken into account.

Although this advantage to commercial owners has been pointed out to DOER in the past, unlike other states' solar production incentive programs, this difference has not been taken into account in the design of the Massachusetts PV production incentive program. ***Avid Solar believes that DOER should take this opportunity to include an adder for residential host owners in the ≤ 25 kW segment to level the playing between commercial owners and residential owners.***

6. The Assumed Rate of PV System Cost Decline Is Too Fast and Not Supported by Recent Experience in the ≤ 25 kW Capacity Segment

There is a stubborn fixed cost of installing a PV system in Massachusetts, caused, in part, by the high overhead associated with participation in various interconnection, permitting, compliance and incentive programs that are complex and varying by project type, utility and municipality. There is also high customer acquisition costs because of the perceived risk of investing in solar and the unfamiliarity of most investors and sources of financing with solar investments. Labor costs are also high in Massachusetts. Additionally, for most wood-framed buildings, some form of additional structural framing reinforcement is required, which incurs the added cost of structural engineering and carpentry expense typically not incurred in other part of the country. For smaller systems, the material (solar technology) costs represent less than half of the price of solar installments.

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[7] The tax basis for PV investments is the total eligible PV investment cost, less half of the federal income tax credit (currently 30%), 100% - (50% x 30%) = 85%. The after-tax depreciation tax benefit is 85% times the marginal income tax rate of 40%: 85% x 40% = 34%.

[8] Note: commercial owners include both commercial host owners and third-party owners

Although there is no debate that solar technology costs are declining globally due to scale and learning curve benefits, the effect of the price decline in the turnkey installed cost in Massachusetts is mitigated, especially in the small PV systems market segment. Most of the overhead costs mentioned above do not scale proportionately with PV system size, which explains why larger PV systems installed in Massachusetts have a lower $/W price as PV capacity increases.

In the fall of 2015, EEA used data on average PV system prices and recent price trends to suggest that the rate of sharp price declines in system prices witnessed in recent years would persist well into the future. EEA did not vet these assumptions with the solar industry before sharing them privately with the legislature, but it did predict that an average 5 kW(dc) system would cost $3.54 in 2016, and $3.22 in 2017. Further it predicted that a 9% annual rate of installed system price decline would continue through 2020, resulting in a cost of only $2.93 in 2018. Additionally, SEA in its Post-1600 report projected a 8.1% annual price decline through 2025, based largely on national price trends, not Massachusetts costs and witnessed price declines for installing solar.

In reality, for the most recent year base on Mass Solar Loan data, residential system prices have decreased less than 3% over the last year, during which time the industry experienced one of the most significant module price declines in history, demonstrating how technology price declines are only a portion of the price equation for the ≤ 25 kW segment—and an increasingly smaller portion as technology prices continue to decrease. The actual cost to install systems in the 4-6 kW(dc) range in the 2016-2017 time range, based on Mass Solar Loan data, was $4.45/W(dc)…a price that is actually *higher* than the price that EEA told the legislature it cost to install those systems in 2014. The aggressive pricing assumptions presented by EEA in 2015 had a major influence on the legislature's decision to reduce the value of net metering credits. Avid Solar hopes that similarly faulty assumptions about both the pricing and the rate of price declines for PV systems in the ≤ 25 kW range does not result in serious mistakes in the evaluation of appropriate compensation for PV investors in this market segment, and how quickly that compensation should decline over time. ***Avid Solar believes the 4% rate of price decline per block and for adders should be reduced at least in half for the ≤ 25 kW capacity segment, and that any new adders that may be warranted for this market segment not be subject to price declines at all, representing the high fixed and overhead cost components (currently) of installing solar in Massachusetts.***[9]

7. The effect of rising interest rates on monthly payments for solar investments should factor into the incentive compensation decision making and value calculations

The Federal Reserve is increasing interest rates, and those interest rates increase the monthly payments for solar loans. Additionally, the very popular and important Mass Solar Loan program for the residential market segment, is gradually withdrawing its Interest Rate Buydown incentive. Combined, the effective interest rates for Mass Solar Loan program participants are increasing significantly, which, in turn is increasing the monthly payment amounts significantly.

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[9] Avid Solar believes there is opportunity to address and lower these fixed and overhead (aka "soft") costs significantly, and encourages DOER and/or MassCEC to pursue additional initiatives to lower them. Avid Solar would welcome the invitation to discuss such opportunities with DOER and other MA solar economy representatives.

The Prime Rate has increased from 3.50% to 4.25% since the beginning of 2016. At the same time, the Interest Rate Buydown has decreased from 3% to 1.5%, and will soon reach its budget limit, at which time it could be reduced to zero. The combined effect, not including additional potential interest rate increases, would be an increase in monthly payment amounts of over 18%, holding all else equal. In other words, the price for investing in solar, is getting a lot more expensive, extending payback periods, before the SMART incentive and its reduced compensation rates take effect.

The Mass Solar Loan program has been a very cost-effective, highly successful and helpful program, allowing many more residents to make solar ownership possible across the state. ***If DOER cannot determine how to factor in the effect of rising interest rates in the design of a self-adjusting incentive program, then Avid Solar strongly encourages DOER and MassCEC to take mitigating steps through the Mass Solar Loan program to ensure that it continues to meet the needs of residential host-owners who want to go solar, making it affordable—i.e., cash-flow positive.***

Thank you for this opportunity to contribute feedback to DOER regarding the design of the SMART program. Avid Solar will gladly make available its data and spreadsheets used in its analysis and preparation of these comments, and would appreciate the opportunity to review that analysis in-person with DOER, and potentially with SEA as well.

Best regards,

Russell Aney, CEO
Avid Solar LLC