BLUEWAVE

November 6, 2019

Commissioner Judith Judson
Massachusetts Department of Energy Resources
100 Cambridge Street
Suite 1020
Boston, MA 02114

Re: Comments on the Proposed Agricultural Solar Generation Tariff Unit Guideline Changes

Dear Commissioner Judson:

Thank you for the opportunity to comment on proposed changes to the Massachusetts Department of Agricultural Resources (MDAR) SMART Agricultural Solar Generation Tariff Unit (dual-use dual-benefit solar) guidelines. We applaud the Department of Energy Resources (DOER) and MDAR for enabling the synergies between solar energy and agricultural land preservation in the Commonwealth. We are grateful to be a partner in that effort and, with the support and encouragement of MDAR, to be working with Knowlton Farms, DOER, and several environmental and agricultural NGOs to undertake one of the first privately-owned dual-benefit / dual-use projects in the Commonwealth. We are grateful as well for your support of BlueWave's partnership with DOER in developing the ASTGU Shade Analysis Tool.

Dual-benefit/dual-use projects are an important means of providing not only clean solar energy but, importantly, for providing farmers with meaningful income and the chance to preserve, and in many cases, expand agricultural production on their farmland. The existing program represents a promising start toward enabling those results. However, if the changes to the dual-use guidelines proposed on October 15, 2019 are enacted in their current form, we are concerned that the opposite will occur. And the result will be the loss of valuable farmland to housing sub-divisions and much larger solar facilities, and a missed opportunity to meaningfully advance land conservation and the Commonwealth's agricultural economy. The comments below amplify on that concern. Thank you for giving them your consideration.

1. **<u>Premature to Update Guidelines for a Nascent Program</u>**

   In the initial guidelines released on April 25, 2018, DOER and MDAR stated that the Departments would *"…make modifications to key eligibility criteria as lessons are learned in constructing and operating ASTGUs."* The dual-use program is so new that the industry has not been able to test the original guidelines and provide real-time data to inform program adjustments. The projects are not yet in construction or production and thereby are not sufficiently advanced to effectively inform any significant changes to the guidelines. In response to the initial SMART dual-use guidelines the solar and farming communities have invested significant time and financial resources to advance dual-use projects. There has been limited public stakeholder conversation about issues with project submissions to date, nor a scientific basis provided to better understand why the proposed changes are necessary.

BlueWave's first SMART dual-use project – a rotational grazing and vegetable cultivation operation with Knowlton Farms in Grafton –will come online next spring. By summer, it should be able to provide initial data that can help inform the direction of the program. We strongly believe that absent feedback from farmers, developers, and a review of lessons from the first batch of projects under the current guidelines, the proposed changes put the entire market for dual-use at risk.

It has taken significant time and effort for market participants (i.e. farmers, developers, and investors) to gain comfort with the existing set of rules and design parameters; significant financial investments have been made; and economic arrangements have been negotiated. Changing guiding principles at this time, before the first set of projects are built, will erode trust in an emerging asset class already viewed as more complex than standard solar.

The proposed rule changes jeopardize BlueWave's existing arrangements with farmers because projects will not be built as planned (e.g. smaller sizes, non-dual use), if at all. The $0.06 / kWh dual-use adder is significant, and BlueWave, in tandem with its farming partners, has invested heavily in developing business models that ensure significant portions of the adder get directed to farming. From this perspective, the proposed changes will cap the financial benefit available to farmers and decrease energy and agricultural production. The changes also threaten to undermine the financial planning farmers have done to date on the basis of foreseen benefits from dual-use, as the stakes involved with managing farms and farm transitions in a volatile agricultural market continue to rise.

Given the significant impact of such drastic changes to the program, the Administration should be transparent in the development of any guidelines and provide adequate explanation for the changes. As with any innovative policy program, it is preferable to utilize real-time data to inform rule improvements and encourage DOER and MDAR to delay any significant changes until the first projects are built.

2. **<u>A Stakeholder Working Group Can Alleviate Dual-Use Uncertainty and Create Better Policy</u>**

Administration of the program and development of any guidelines should be undertaken through a transparent and collaborative process. In order to provide clarity in the direction of the program and a platform for constructive discussion, BlueWave proposes formation of a dual-benefit/dual- use working group convened by the Executive Office of Energy and Environmental Affairs and comprised of a diverse group of stakeholders. (MDAR, DOER, farmers, developers, academics, advocates, etc.) The initial purpose of the working group would be to expeditiously review the proposed guidelines and provide recommendations for any changes in the current guidelines that may be necessary.

We suggest the following working group objectives for consideration by EEA, DOER and MDAR:

i. Clarify and clearly state the goals, priorities and intent of the dual-use program.

ii. Clarify and clearly state the risks and concerns projects should address.

iii. Establish clear, distinct, and transparent areas of discretion under which DOER and MDAR will each review projects.

iv. Draw upon available peer-reviewed research to establish simple and clear standards.

v. Establish an easy-to-follow review framework that merges solar and agricultural interests. Such a framework should assess factors such as: (i) availability of scientific studies across disciplines that inform the efficacy of a variety of proposed dual-use designs and farming plans (ii) flexibility of farm plans, (iv) farmer experience, (v) the history of a given property or farm, (vi) health and viability of farm enterprise, and (vii) the development context. These factors should be considered as informed by the first batch of dual-use projects that are built and operated under the current guidelines, and given respective weight in a review process informed by the working group on an on-going basis.

vi. Expeditiously provide recommendations for program improvement to EEA, MDAR and DOER.

3. <u>Proposed Guidelines are Overly Restrictive and Will Render Most Projects Infeasible</u>

The proposed changes are so restrictive, unpredictable and complicated that most farmers and project developers who have found the program worthwhile will likely choose not to participate under the proposed guidelines. The program requirements are overly burdensome as compared to other programs that MDAR administers.

If the proposed changes identified below were to be adopted BlueWave would see a 75% decrease in our dual-use pipeline. There are two main factors that cause this decrease: (i) decreased power density (kWdc per acre) to comply with the revised sunlight requirements, and (ii) lower overall project sizes on account of fixed real estate, lower power densities, and the 2.5 MWDC cap. Such reduced project sizes cannot tolerate the high interconnection costs now commonplace across Massachusetts, nor take full advantage of sizing optimal energy storage ratios the rest of the SMART program is able to utilize.

While two thirds of BlueWave's current dual-use not move forward, the remainder would be converted to standard solar. If on goal of the Departments is to lessen the land impacts of solar through more innovative forms of development, the opposite would occur considering that (i) < 7 MWAC, or < 1% of the entire SMART program, has been approved to date as dual-use, and (ii) developers will be pushed towards developing standard solar with trackers and battery storage as that is the more straightforward, economic option in comparison.

It is in this context that BlueWave offers comments on the following aspects of the proposed guidelines:

Shade Requirements

MDAR's desire to protect agricultural yields is innate, but through the proposed guidelines, there are discrepancies between the requirements and the research being used to support the creation of these guidelines. For example, the revised guidelines propose a sunlight reduction of no more than 40% on any square foot of land, as informed by results from the flagship agrivoltaic research project at UMass under Professor Stephen Herbert. This project examines crop yields under shaded conditions produced by panels with 2', 3', 4', and 5' spacing. When examining the average yield reductions of different crop yield metrics across the study years (2016-2018), according to the publicly available data on the UMass Extension website, there are no designs that reduced yield of any crops studied more than 30%.[1][2] Leafy greens (kale and swiss chard) had a reduction of 11-30% in fresh weight, 12-31% reduction in dry weight, and 13-18% reduction in leaf number across study years. Flowering vegetables (peppers, broccoli, and common bean pods) had anywhere from 8% reduction to 7% increase in fresh weight, 3% reduction to 18% increase in dry weight, and 9% reduction to 6% increase in fruit/pod number across study years.

BlueWave modeled this design in the SMART tool in order to compare it to the proposed guidelines (see appendix). The results fail the proposed guidelines of 40% sunlight – as well as current SMART requirement of 50% sunlight – across all designs (2', 3', 4', and 5' spacing). The shade rule failures occur over ~1/3 of the study area, which is where most crops appear to have been grown.

Despite this, the project still essentially meets the proposed average shade requirement of 30%. This observation proves that "average shade" is not an accurate indicator of truly available sunlight. This inconsistency, in addition to the shade rule violations and varied results in the pilot, shows that the project is inconclusive in determining the efficacy of dual-use in Massachusetts and more data through these projects are needed.

It is in the context of these findings that we offer the following:

- Power densities (kWdc/acre) to meet the proposed maximum 40% shade and 70% average sun requirements would decrease across BlueWave's portfolio on account of having to increase row spacing by an average of 30%.
- In turn, this would decrease the size of projects by 35% on average, compared to projects designed to comply with existing dual-use guidelines.
- Single Axis Tracker manufacturers cannot currently support the row spacing distances the proposed guidelines would require, on account of components needed to span between rows to enable uniform tracking. The row-spacing distances required by the proposed sunlight requirements exceeds the manufacturing tolerance for this component, thus eliminating SAT as a feasible option for dual-use.

Given the specious and unsubstantiated basis for increasing sunlight requirements, and its significant deterring impact on the viability of dual-use, we strongly recommend keeping the currently proposed sunlight / shade requirements in place until more is understood.

[1] 2016-2017 data: https://ag.umass.edu/sites/ag.umass.edu/files/pdf%2Cdoc%2Cppt/crop_yield_comparisons_2016_-_2017_umass_farm_nrel_co-location_project.pdf

[2] 2018 data: https://ag.umass.edu/sites/ag.umass.edu/files/pdf-doc-ppt/herbert_crop_yield_comparisons_2018.pdf

Land Equivalency Ratio

The proposed agricultural yield (70%) and Land Equivalency Ratio (1.4) metrics are highly specific in determining the "baseline yield" requirement that projects must demonstrate in their Predetermination Application. Such specificity ignores the every-day realities of farming in that no ideal "baseline yield" exists. Farmers frequently experiment with different methods that result in different yields from year to year, and the multitude of factors that influence yield in a given growing season (e.g. weather conditions, blight, drought, human error, etc.) suggests that the notion of establishing a "baseline yield" as the ideal metric from which to assess the merit of a project is inadvisible. Further, not all farms have historical data, nor perfect data, from which to establish such a baseline, and the Predetermination Application itself invites applicants to consider diversification strategies that cover products not previously grown.

One possible strategy to reduce subjectivity created by this requirement is through a methodology incorporated via the working group that helps standardize assessment approaches for different crop types. Light intensity is the main determinant for when photosynthesis occurs, and all crops have their own range of light intensity where they are most productive. This phenomenon, known as Photosynthetically Active Radiation, or PAR, is the portion of the light spectrum that plants utilize for photosynthesis. PAR is a well-researched measurement that has been widely studied in academia and applied across agriculture, horticulture, forestry, plant biology, and other natural-resource based industries. PAR has been measured and categorized under a wide variety of contexts, from outdoor Agroforestry and Agrivoltaic crop trials to controlled greenhouse experiments, and in the context of some research, lays the foundation for cataloging how much sunlight is required for crops to achieve optimal photosynthesis.

The academic paper from the Japan Agricultural Research Quarterly (JARQ) provided in the appendix of these comments, for example, lays out a menu of PAR ranges for 28 crops, many of which are grown in Massachusetts.[3] We provide this as an example to illustrate how a working group might organize its thinking around collective efforts to understand the efficacy of dual-use, and strive for ubiquitous standards upon which to compare project designs.

In this context, PAR can be measured under different shade profiles associated with dual-use designs (e.g. modeled by the ASTGU Shade Tool), and research currently underway with solar developers in southeastern Massachusetts, cranberry growers, and the UMass Cranberry Extension is focused on investigating this question. The research seeks to understand (i) PAR availability under single-axis tracker designs and (ii) cranberry growth responses to PAR. Since PAR data gathered from this study applies to a specific solar design common in the industry, these findings should inform a broader understanding as to how much PAR will also exist for crops proposed for other dual-use projects with similar designs.

It can also help substantiate findings proffered by the ASTGU shading analysis tool.
BlueWave is committed to offering its projects, such as the one in Grafton, for similar research purposes so that we can add to the growing body of knowledge surrounding PAR availability under dual-use designs and its influence on crop growth. BlueWave stands ready to work with the UMass

[3] "Effects of Various Radiant Sources on Plant Growth", Shini Tazawa (1999)
https://www.jircas.go.jp/sites/default/files/publication/jarq/33-3-163-176_0.pdf

Extension, MDAR, and other stakeholders to further this important discussion, and looks forward to doing so.

New "Optimized Balance" definition

While we appreciate MDAR's attempt to clarify the current guideline requirement of optimizing both energy and crop production, this approach lacks sufficient context and definition of key concepts and is subjective. Specifically, it is not clear what "post-/pre- kW capacity percentage" implies. It is assumed to refer to the kW capacity achievable under standard solar compared to dual-use. In this sense, there are any number of ways this calculation could be performed with respect to both solar and agriculture, depending on the varying definition of "optimal" and real world realities. Design philosophies vary from developer to developer, and project details vary by circumstance. The same applies to farming methods, as well as individual farms. Real world circumstance may prevent solar developers and farmers from achieving "optimal" outcomes in previous years that are interpreted to provide the baseline for this type of analysis.

We recommend DOER revisit this concept after the first dual-use projects are built and the data can be discussed in the context of a working group.

2.5 MWDC Cap

BlueWave has assembled a significant portfolio of dual-use projects with the expectation that dual-use will have sufficient DC sizing and design flexibility to address a wide range of interconnection and storage challenges**.** The proposed guidelines will significantly reduce the opportunity to combine dual-use projects with storage. All of BlueWave's dual-use projects have been sized and planned around the current 2.0 MWAC cap. The proposed 2.5 MWDC cap would render projects unviable because there is less generation and many projects cannot tolerate the significant interconnection costs without the economies of scale needed.

Standard interconnection study timelines can extend to 12 months or more, and because interconnection costs across MA are trending upward, projects with the DC-sizing and storage flexibility required to defray costs and take advantage of emerging storage markets are the ones that will remain financially viable. Since current market conditions call for storage DC:AC ratios of roughly 3:1 for projects that do not have the dual-use adder (e.g. 6.0 MWDC for 2.0 MWAC), capping dual-use DC-sizes at levels below market conventions will kill many projects.

In all, pairing DC-size flexibility and energy storage with dual-use should be viewed as a positive lever that helps the Commonwealth achieve optimal outcomes, specifically, of increasing or maintaining agricultural production and increasing storage capacity and its benefits to the grid, simultaneously. However, we understand larger DC/AC ratio projects potentially warrant greater discussion and review through the proposed working group.

Justification and Substantiation – Providing Data on Incremental Costs

We appreciate MDAR's desire to better understand how the adder is used for dual-use projects; however, requiring projects to justify need based on the additional cost of racking is (i) prescriptive and ignores the wide variety of other reasons that the adder represents sound energy and land conservation policy. This includes compensating for higher O&M, incentivizing farmers to work land different than open fields, paying lease rent that provides greater benefit to a landowner than standard solar, and compensating for the lost value of a smaller dual-use project compared to standard solar. Considering the Community Solar and Energy Storage adders are not subject to such scrutiny, we believe this is an unfair requirement that further disadvantages dual-use compared to other areas of the SMART program. We recommend the department remove this requirement from the guideline entirely.

4. The Current Review Process Creates Market Uncertainty

We recognize that the project approval process is a work in progress and that DOER's role in authorizing project approvals is not yet clearly defined. Recognizing that ultimate authority to approve dual-use dual-benefit solar rests with DOER, we look forward to further discussions within the context of a working group as to how this role can be more formally established.

5. Dual-Use Can be an Alternative to Permanent Development

At its core, dual-use dual-benefit solar is a conservation exercise that should be promoted over other types of land development. Many BlueWave partners face difficulty keeping their agricultural operations viable, and as many approach retirement or similar crossroads, questions of land succession almost always result in consideration of development. Without solar, the majority of our landowner partners have expressed that they would have sold their land for some form of development (most often housing) to realize income and none have current or future plans to convert their land to permanent conservation.

In the case of one BlueWave project in Dighton, the farm projected to host a recently permitted dual-use array (pending submission to DOER) is surrounded by development pressure that will undoubtedly threaten the property should the project fail to materialize. The property has eight direct abutters that have either developed housing since 2015, or are currently approved by the Town to build housing in the near future.

The current farmer has already engaged a younger farmer willing to take over the operation under the panels upon his retirement. The younger farmer is excited about the potential to produce on land for the duration of the SMART program that would otherwise be too expensive to acquire. Faced with this estate planning reality, the current farmer expressed that he would sell the land for housing to supplement his retirement if it were not for dual-use. He views dual-use as the main strategy to maintain the farm and transition it to the next generation of management. Given the steep interconnection costs facing this specific project, however, the proposed guideline changes to DC-size and sunlight requirements threaten to render the project economically unviable– and by extension, the farm succession plan already well underway.

6. Dual-Use Dual-Benefit Can Increase Positive Ecological Outcomes Across the Commonwealth

In many cases, dual-use dual-benefit solar can enhance land ecology through sustainable land management strategies rooted in philosophies that include but are not limited to: building healthy soils, promoting carbon sequestration, rotating crops, promoting cover crops, reducing tillage, facilitating sustainable grazing, enhancing species diversity, promoting water conservation, and improving upon input intensive industrial farming methods. These methods, otherwise known as regenerative farming, hold great promise for drawing C02 out of the atmosphere while building more resilient farms and rural communities.

According to a Rodale Institute review, regenerative agriculture systems (specifically, conventional crops and grazing) have the potential to sequester more than 100% of current C02 emissions globally, if these practices were adopted on a wide scale.[4] With far reaching benefits including improved soil carbon stocks, decreased greenhouse gas emissions, equal or greater yields over conventional agriculture, improved water retention and plant nutrient uptake, and improved farm profitability, regenerative agriculture can play a major role in revitalizing farm communities, improving biodiversity, and enhancing the resiliency of ecosystem services across Massachusetts.

It will be important for the Commonwealth to invest in building the human capacity, knowledge infrastructure, and known agricultural techniques required to promote regenerative agriculture on a large scale. Dual-use dual-benefit solar will play an important role in getting there, and BlueWave stands ready to work with the Departments to develop farm system trials that demonstrate the potential of regenerative agriculture as a climate change solution, all while building hubs of skills incubation and support networks for farmers eager to get into the practice.

7. <u>Conclusion</u>

Dual-benefit/dual-use projects enable the creation of clean, local power that facilitates the preservation or expansion of agricultural farmland, increases positive ecological outcomes and provides meaningful income for farmers. DOER and MDAR's leadership in establishing these possibilities through the SMART program and the existing dual-use guidelines will create meaningful benefits for farmers and local communities and move the Commonwealth closer to meeting its clean, energy, climate and agriculture goals.

We are concerned that the recently proposed changes to the dual-use guidelines will significantly limit or prevent dual-benefit/dual-use projects from being developed. BlueWave appreciates the opportunity to submit comments raising concerns about the proposed changes and offer recommendations on ways to improve the current process and ensure the integrity of dual-use development.

Thank you for considering our comments. We look forward to working together to help Massachusetts realize important conservation and agricultural promotion opportunities.

John DeVillars
Chairman

Mark Sylvia
Chief of Staff

[4] "Rodale Institute: Regenerative Organic Agriculture and Climate Change – A Down-To-Earth Solution to Global Warming" (2014) - https://rodaleinstitute.org/wp-content/uploads/rodale-white-paper.pdf

Appendix – MODELLING UMASS SCHOOL OF AGRICULTURE RESEARCH DESIGN USING DOER SHADING TOOL

Professor Stephen Herbert of the UMass Stockbridge School of Agriculture has been measuring biological yield under various panel configurations to isolate shade impacts. **BlueWave modeled this design to see how it would compare to the currently proposed Guidelines. The results clearly violate the proposed guidelines, most notably the maximum shade ranging from 60-81%, vs. the recommended 40%. Additionally, anywhere from 25-42% of the study area violates the shade rule, but still provides a low average shade level. This, coupled with the yields represented by Herbert's work, show that there is no conclusive basis to couple a minimum sunlight requirement with an average sunlight requirement.**

Proposed System Design		**Shade Model Results**	Design - 2 ft	Design - 3 ft	Design - 4 ft	Design – 5ft
Configuration	3 panels landscape	Max Shade	81%	74%	63%	60%
Panel Spacing	2'-5' space between each	Average Shade	36%	32%	30%	28%
Row Spacing	12'	Min Shade	0%	0%	0%	0%
Tilt	20-degrees	Area Under 40% Shade	58%	63%	69%	75%
Azimuth	180-degrees (true south)	Area Above 40% Shade	42%	37%	31%	25%
Center Height	10'					
Low Edge Height	8.3'					

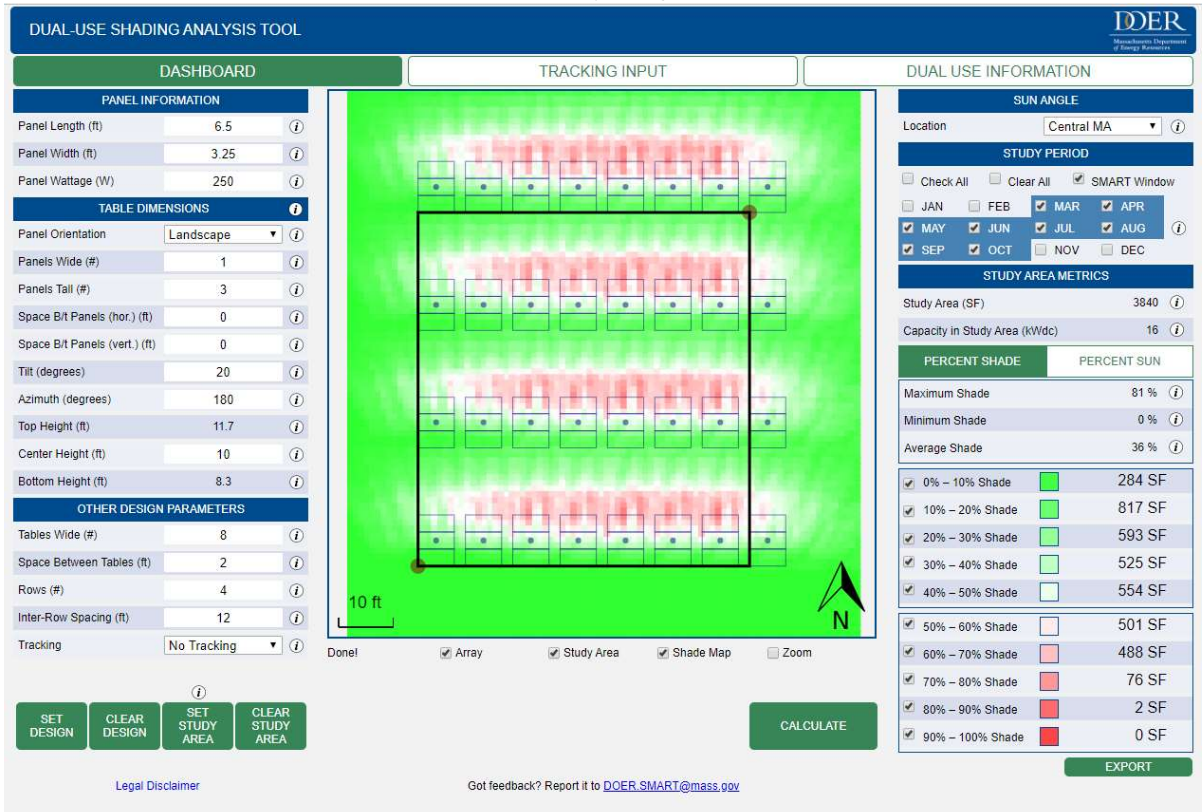
These solar designs do not comply with either the old (50%) or new (40%) minimum shade requirements of the proposed ASTGU guidelines.

Analysis of Crop Yield Metrics

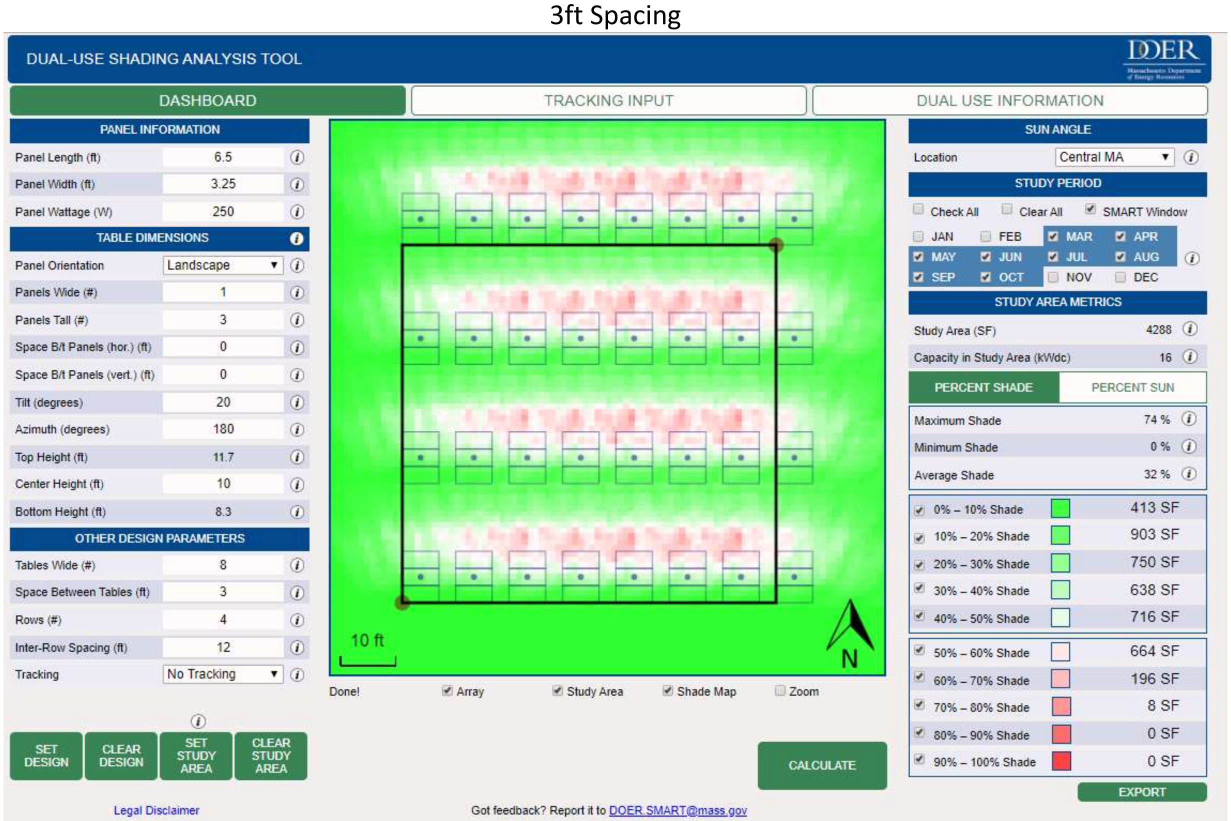
	Average Yield Reduction Compared to Control Plot Across Study Years (2016 - 2018)				
		Spacing (ft)			
	Crop Metric	**2**	**3**	**4**	**5**
Flowering Vegetables	Fresh Weight	8%	-2%	4%	-7%
	Dry Weight	3%	-17%	-1%	-18%
	Fruit Number	3%	5%	9%	-6%
Leafy Greens	Fresh Weight	27%	30%	26%	11%
	Dry Weight	28%	31%	23%	12%
	Leaf Number	18%	17%	15%	13%

When examining the average yield reductions of different crop yield metrics across the study years (2016-2018) of the flagship research done by Professor Stephen Herbert at UMass, there are no designs that reduced yield of any crops studied more than 30%. Leafy greens (kale and swiss chard) had a reduction of 11-30% in fresh weight, 12-31% reduction in dry weight, and 13-18% reduction in leaf number across study years. Flowering vegetables (peppers, broccoli, and common bean pods) had anywhere from 8% reduction to 7% increase in fresh weight, 3% reduction to 18% increase in dry weight, and 9% reduction to 6% increase in fruit/pod number across study years.

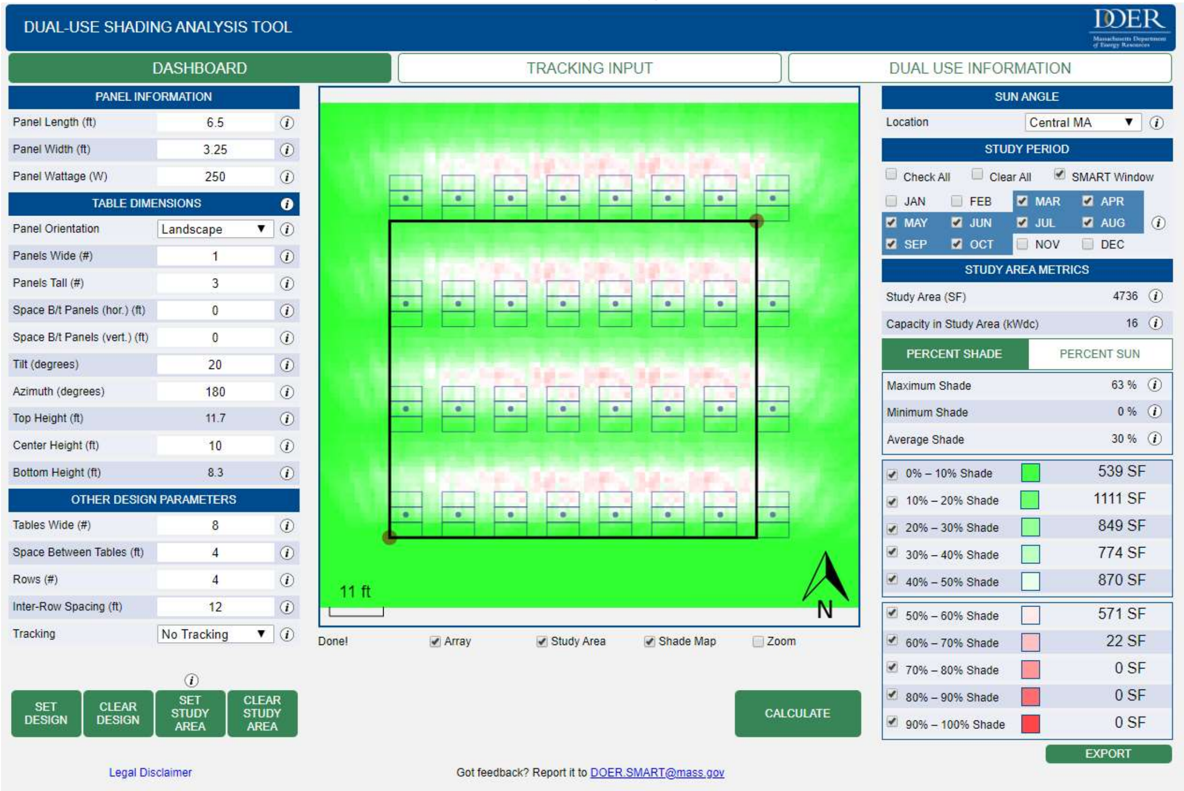
2ft Spacing



3ft Spacing



4ft Spacing



5ft Spacing