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May 31, 2020

Department of Energy Resources
100 Cambridge Street, Suite 1020
Boston, Massachusetts 02114
Attn: Ms. Kaitlin Kelly

Subject: SMART Public Comment re: 225 CMR 20.00 and Guidelines Regarding Land Use, Siting, and Project Segmentation

Proposed SMART statute 225 CMR 20.00 provides guidelines to encourage the further development of photovoltaic energy sources throughout the Commonwealth. My comments attempt to strengthen those guidelines through some changes and additions. They reflect my experience as a former Belchertown Planning Board member, and as a dean in the College of Engineering at Cornell University and vice president at Colgate University where my responsibilities included oversight of large construction projects.

Key points in my review are:

1. The construction measures proposed are particularly challenging for those in the Connecticut River Valley due to ubiquitous bedrock, steep slopes and thin soil layers.
2. Unprotected forested areas appear to be neglected in Land Use and Performance Standards.
3. Civil engineers may certify design elements of proposed SMART eligible arrays, as the revision requires, but additional engineering oversight is needed to ensure public safety.
4. Certification of site plans by a civil engineer does not relieve DOER of its responsibility to ensure the safety of SMART sites.
5. Current models of rain events underestimate the projected volume of future events, leading to underdesigned site engineering and risks to health and safety.
6. Decommissioning arrays mounted in bedrock presents a health hazard.
7. Risk analysis would strengthen support of the SMART program by all parties.

My comments reflect these principles:

1. Keep people healthy and safe.
2. Support local and state economic prosperity.
3. Preserve the essential character of communities.
4. Reduce carbon footprints locally and globally (a corollary of principle 1).
5. Acknowledge the merits of opposing points of view.

Some of these principles are in tension and more of one means less of another; nevertheless, this is the lens which shapes my comments. In addition, I've highlighted perceived errors and omissions.

The Connecticut River Valley Hill Towns is one of the most sensitive regions in the Commonwealth as measured by the profusion of underlying bedrock, steep slopes on bedrock, thin soil layers, standing water, lush tree cover, and the region's contributions to aquifers. The SMART program does not adequately protect its people or land, and, on the basis of that premise, DOER should reconsider elements of 225 CMR 20.00, and more specifically the Land Use and Siting Criteria and Performance Standards proposed. My detailed comments follow, and I begin with an observation about SMART subsidies, justice, and my perspective on DOER's obligations.

Just after the promise of a new solar subsidy program last year, many residents received notice that about 100 acres would be clearcut for solar arrays on the tops of the Pelham Hills in Belchertown. This area on West Hill and Smith's Pastures includes some of the most verdant forest in Western Massachusetts. How did we respond? We put together a team that spent hundreds of hours researching 310 CMR 10, 310 CMR 36, 321 CMR 5.00, 301 CMR 11,

local wetlands law, the Natural Heritage and Endangered Species Program, Areas of Critical Environmental Concern, aquifer protection laws, wellhead protection laws, local zoning ordinances, microclimates, hydrology, dendrology, stormwater management requirements, wildlife protections, site analysis, and soil classifications to position ourselves to evaluate the proposed projects. Along the way, we needed legal assistance that cost \$25,000 to date. Our team fortuitously included subject matter experts, researchers, public relations professionals, writers, fundraisers, attorneys, former planning board members, former town officials, and a former USDA administrator. DOER's SMART program puts pressure on developers to aggressively and quickly move forward with design and qualification while subsidy slots are available. Community members, believing their natural environment is at risk, have no choice but to respond with organizing efforts, attorneys, public relations programs, and the like. Time, money, and intellectual capital is wasted throughout the Commonwealth. I can't solve this problem, but I do know that DOER is an important contributor, and, I hope, a willing architect of the solution. These problems often begin with an incomplete or erroneous understanding of the environmental conditions that impact siting, site preparation, and anticipated construction, and that is where I focus my comments.

Context: Importance of the Hilly Terrasin Adjacent to the Connecticut River Valley

Where do people live? Massachusetts has the largest population of the New England states: almost 7 million or about 46% of the region's inhabitants. It is old, having been settled in 1620. It has slightly more women (51%) than men (49%). The largest city in New England is Boston with a population of 617,594 and 4,552,402 in its metropolitan area.¹ Importantly, the population density differs dramatically across the state, in turn influencing the locus of resources and government attention.

Elevations

Like many states, the Commonwealth reflects a broad range of values in virtually every physical dimension: topography, geology, hydrology, and ecology. Figure 1 illustrates the vast range of elevations in the state's three primary regions: the Berkshire Range, the Connecticut River Valley and the Eastern Shore. Significant elevations above sea level range from Mt. Greylock in the Berkshires at 3,491 feet, to elevations of 1,000-2,500 feet in the Holyoke, Metacomet, Mount Tom, and Pelham Hills adjacent to the Connecticut River Valley.

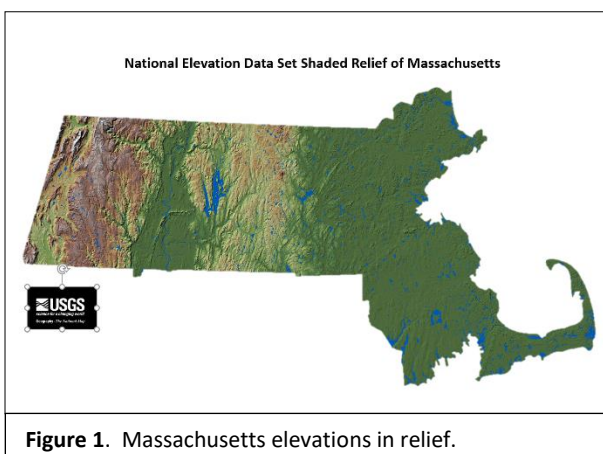


Figure 1. Massachusetts elevations in relief.

Bedrock

Underlying the state are extensive fingers of bedrock (granite, per MassGIS Oliver), displayed in red, in the hills around the Connecticut River Valley, the Worcester Corridor, and along the Eastern Seashore as shown in Figure 2. This geologic swath is called the Bronson Hill Sequence (BHS). Among the towns within this area from the Vermont border to the Connecticut border are: Northfield, Warwick, Erving, Orange, Montague, Wendell, Leverett, Shutesbury, Petersham, New Salem, Pelham, Hardwick, Ware, Belchertown, Palmer, Monson, and Hampden. The area of bedrock under these towns (again, in red) is approximately 463 square miles or 296,320 acres, and its impact on most proposed solar projects is substantive.^{2,3} For example, a recent solar array proposal by Blue Wave Solar (developer) on land owned by Cowls Lumber Company at 0 Gulf Road in Belchertown sited the array primarily on an area of 2.18 million ft². Bedrock is under 1.80 million ft², or 83% of that lot. In fact, nearly half the Commonwealth is situated over bedrock, and as demonstrated in Figure 3, shallow bedrock and bedrock outcroppings, represented by horizontal lines, are present throughout the central Valley and its hills.

¹ <https://en.wikipedia.org/wiki/Massachusetts>

² http://maps.massgis.state.ma.us/map_ol/oliver.php. See Physical Resources/Bedrock Lithology.

³ Narrow shards of mafic rocks (light green) and metamorphic rocks (orange) are present, as well. Through mineralization mafic rocks become impermeable to water.

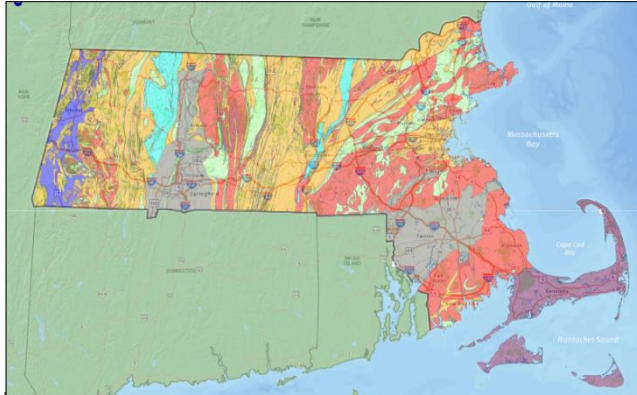


Figure 2. Extensive swaths of bedrock (granite per MassGIS Oliver), shown here in red, underlie the Connecticut River Valley, Worcester Corridor and the Eastern Shore—about 50% of the state.

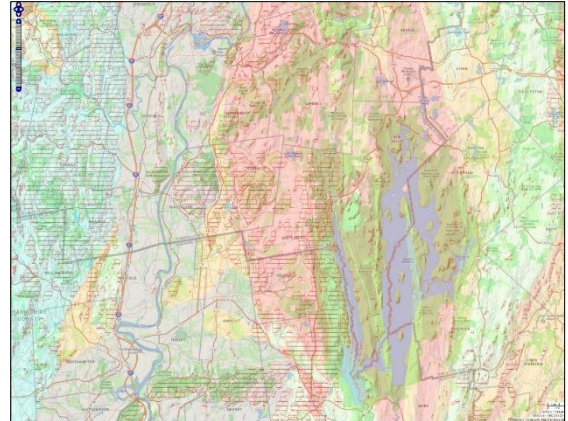


Figure 3. This map of the Quabbin area of the Connecticut River Valley shows extreme amounts of shallow bedrock and bedrock outcroppings (horizontal red lines) throughout the Pelham Hills and Holyoke Range areas. Pink areas are bedrock substrate.

Slopes

Grades throughout the BHS region's center are shown in Figure 4. Slopes of 25-35% are highlighted in purple and 15-25% in brown. Clearly, the entire area is pock-marked with steeply sloped areas over the bedrock which, in turn, lead to thin soil layers or a lack of soil (outcroppings) resulting from erosion. Much steeper grades are present in the area but cannot be displayed in MassGIS Oliver. For example, grades between 50% and 65% were discovered with Google Earth Pro at the proposed array site at Gulf Road.

Table 1 shows representative hills and mountains with significant elevations in BHS towns. Fifteen of the 20 towns (75%) have slopes exceeding 10% and 8 (53%) have slopes exceeding 20%.

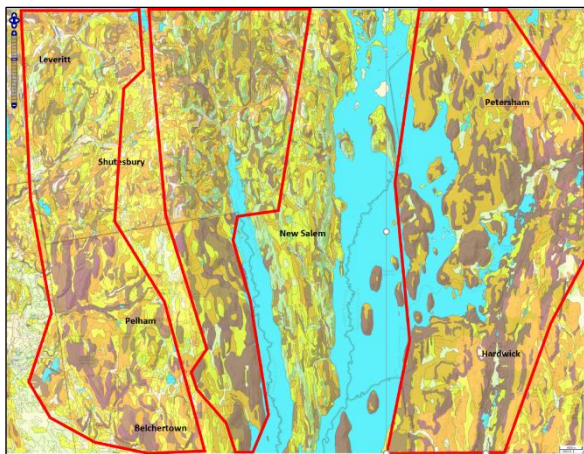


Figure 4. This map shows the central Quabbin region of the Connecticut River Valley. Slopes of 15-25% are shown in dark brown and slopes of 25-35% appear in purple. Source: MassGIS Oliver/Soils/Soils by Slope/42.41620° N 72.35509° W

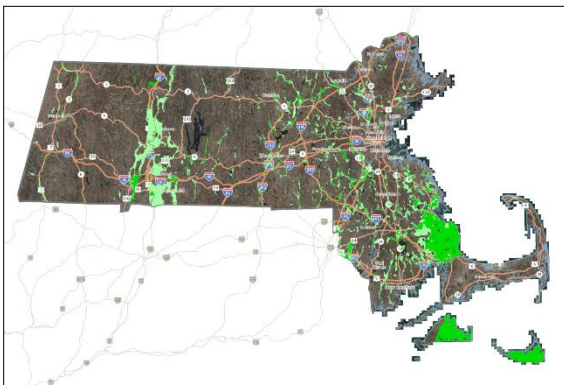


Figure 5. Nearly the entire Connecticut River Valley and adjacent land serves as an aquifer serving various locations in Massachusetts.

Water Supply

Almost the entire Connecticut River Valley and its Hill Towns serve as an aquifer for various parts of the state as shown in green in Figure 5, and, of course, the Quabbin Reservoir services Boston

Forests

Figure 6 demonstrates the extensive forest cover, in green, in the Berkshires and much of the Connecticut River Valley and adjacent land. Forest cover in the region is typically

classified as Prime 2 and Prime 3 forest land defined as 120-154 ft³/ac and Prime 3, 85-119 ft³/ac of trees.⁴ Both categories comprise very dense forests of Northern Red Oak and White Pine.

Town	Locations of High Land	Elevations of High Land	Grades Near High Land
Athol	Kelton Hill	832	4%
Belchertown	West Hill	1,069	62%
Erving	Rattlesnake Mountain	1,059	26%
Hampden	Minnechoag Mountain ¹	881	13%
Hardwick	Dougal Hill	1,060	10%
Leverett	Ingraham Hill	827	33%
Ludlow	Minnechoag Mountain	704	9%
Monson	Moon Mountain	1,100	11%
Montague	Quarry Hill	823	20%
New Salem	Packard Mountain	1,268	7%
Northfield	Brush Mountain	1,297	29%
Orange	Walnut Hill	886	24%
Palmer	Baptist Hill	806	15%
Pelham	Poverty Mountain	913	30%
Petersham	Bald Hill	1,047	6%
Shutesbury	(hills are unnamed)	797	11%
Ware	Brimstone Hill	805	36%
Warwick	Bolster Hill	1,020	67%
Wendell	Bullard Hill	1,194	11%
Wilbraham	Wigwam Hill	844	18%

¹Same name as Ludlow high land but different spelling.

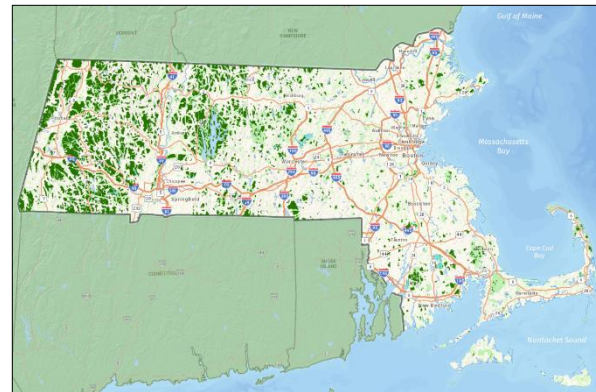


Figure 6. Extensive forest cover in the Berkshires and Connecticut River Valley.

In summary, then, the hilly terrain around the Connecticut River Valley (the Hill Towns) is located over shallow bedrock, with outcroppings throughout, on steep slopes resulting in thin soils, in densely forested areas, draining to aquifers that serve millions of people. These conditions result in commercial solar array sites that are exceedingly difficult to model, and they overwhelm even the most sophisticated stormwater management strategies, especially in the absence of trees that mitigate these conditions. This is not theory. The failures at Orange and Williamsburg and the erosion and sediment around the Ware/West Brookfield site are empirical proof of the difficulty.

My detailed comments that follow compare these environmental conditions with the Land Use and Site Criteria and Guidelines provided in 225 CMR 20.00.

Comments concerning 225 CMR 20.05(5)(e). Land Use and Siting Criteria.

1. 225 CMR 20.05(5)(e)5. Perhaps the most pernicious, but consequential, issue requiring additional attention in the revision of 225 CMR 20.00 is ineligible land use in which, unfortunately, no guidance is provided with respect to grades on which arrays can be sited. **Recommendation:** Prohibit SMART projects on: (1) array sites with slopes greater than 10% from north to south and east to west, (2) total project areas with slopes greater than 10% from north to south and east to west, and (3) project sites with slopes exceeding 10% on contiguous land extending 2,000 ft from the project boundary.
2. 225 CMR 20.05(5)(e)5. This article provides no guidance with respect to clear-cutting of forests, most of which in the Connecticut River Valley and Hill Towns are Prime 2 and Prime 3 quality and deter soil erosion, as stated above. **Recommendation:** Determine that a maximum of 10 acres of trees may be clear cut from any solar array site.
3. 225 CMR 20.05(5)(e)2 through 5. The section of land use and siting definitions and criteria is difficult to interpret due to confusing writing and missing and inconsistent use of conjunctions “and” and “or.” I created Table (2) to help me understand and recommend it to you, below.
4. Various undefined terms contribute to the confusing organization in this section, including Ground-mounted Solar Tariff Generation Unit, Capacity (only capacity block is defined), Solar Power Generation Unit, and the abbreviations STGU and SPGU. **Recommendation:** Define them in 225 CMR 20.02.

⁴ http://maps.massgis.state.ma.us/map_ol/oliver.php/Physical Resources/Prime Forest Land

Table 2. Land Use and Siting Criteria in 225 CMR 20.00. SOLAR MASSACHUSETTS RENEWABLE TARGET (SMART) PROGRAM	
<p><u>Category 1 Agricultural</u></p> <ol style="list-style-type: none"> 1. Land in Agricultural Use, or 2. Important Agricultural Farmland, and 3. Agricultural STGUs, or 4. Building Mounted Solar Tariff Generation Units, or 5. Floating STGUs, or 6. Canopy STGUs, or 7. STGUs sized to meet no greater than 200% of annual operation load of an agricultural facility 	<p><u>Category 1 Non-Agricultural</u></p> <ol style="list-style-type: none"> 1. not on Land in Agricultural Use, or 2. not on Important Agricultural Farmland, and 3. Ground-mounted STGU and capacity <= 500 kW, or 4. Building-mounted STGUs, or 5. STGUs sited on Brownfields, or 6. STGUs sited on Eligible Landfills, or 7. Floating STGUs, or 8. Canopy STGUs, or 9. on land previously developed, or 10. sited within a solar overlay district, or 11. complies with local zoning explicitly addresses solar or power generation
<p><u>Category 2</u></p> <ol style="list-style-type: none"> 1. STGUs not in Category 1, and 2. ground-mounted, and 3. capacity >500 KW and <=5,000 kW, and 4. sited on land not previously developed, and 5. zoned for commercial or industrial use 	<p><u>Category 3</u></p> <ol style="list-style-type: none"> 1. STGUs not in categories 1 or 2, and 2. ground-mounted
<p><u>Ineligible</u></p> <ol style="list-style-type: none"> 1. SPGUs on protected space, as established under Article XCVII of the Amendments to the Constitution, and do not meet the Category 1 criteria, or 2. SPGUs sited in a wetland Resource Area, as defined in 310 CMR 10.04: Definitions, excluding Buffer Zones as defined in 310 CMR 10.04: Definitions, except as authorized by all necessary regulatory bodies, and 3. Solar photovoltaic Generation Units sited on properties included in the State Register, as defined in 950 CMR 71.03: Definitions, except as authorized by regulatory bodies. 	

Comments concerning 225 CMR 20.05(5)(e)6. Performance Standards.

1. 225 CMR 20.05(5)(e)6 begins its narrative with the phrase: “certification from a professional engineer that the construction of the Solar Tariff Generation Unit complied with the following standards when installed on Land in Agricultural Use, Important Agricultural Farmland, or other pervious open space.” This statement is problematic from a variety of perspectives:
 - a. “Professional engineer” is different from a registered professional engineer licensed to practice in Massachusetts. **Recommendation:** Require the latter.
 - b. “Pervious open space” is undefined, and the term “pervious” has been widely disputed with respect to solar panels and the ground beneath. **Recommendation:** Define the term in 225 CMR 20.02.
 - c. The certification requirement in this section would mean that the certifying engineer would have to be on site or visit the site regularly during construction. A brief walkthrough after construction would not be sufficient to certify most of the requirements, and especially those requiring site preparation and soil manipulation. **Recommendation:** Require certification after planning, 50% and 100% site preparation, and 50%, 75% and 100% construction.
 - d. While the certification requirement is important, the real problems with major capital projects, including commercial solar arrays, begin in design. For example, the Gulf Road project in Belchertown designed by a registered Massachusetts engineer was rejected as unsafe by the Planning Board after some 13 design iterations. **Recommendations:** DOER should plant a flag in the sand during design with respect to its Performance Standards. At a minimum, the statute should recommend additional oversight and plan review by: (1) an independent engineering firm, and (2) a stormwater analysis by an independent hydrologist or geohydrologist.
2. 225 CMR 20.05(5)6 and 7. It is unclear if or how the Performance Standards apply to land in Chapter 61, as well as the specified 61A. This is critical because commercial solar developers are targeting large swaths of forested land for development. The newly written article (7) clearly applies to certain forested land protected by

statute, but not unprotected forested land. In fact, unprotected forest land seems to be classified as Category 2 Land Use in the new article, 225 CMR 20.05(5)7, but if that is true, then the Performance Standards in 225 CMR 20.05(5)6 do not apply because it addresses only Land in Agricultural Use, Important Agricultural Farmland, or other pervious open space (the latter is not typically considered forest). In fact, Category 2 land use seems to be missing Performance Standards. *If unprotected forested land is not addressed in 310 CMR 20.00, or if it is subsumed in any other Land Use category, then all users of the statute should be clear about its omission or classification.* **Recommendation:** This section should specify its application to unprotected forested land.

3. 225 CMR 20.05(5)(e)6a through 6c. While a 500 kW project might occupy a few acres requiring little soil manipulation, a 5 MW project could occupy 25 to 35 acres requiring heavy equipment to grade and smooth. Soil will be grossly disturbed and changed from an A or B grade to grade C or D. The existing statute language, then, would prohibit STGUs from all but the smallest land areas. **Recommendation:** The requirement about undisturbed land is impractical and should be rewritten.
4. 225 CMR 20.05(5)(e)6d. As shown in Figure (2) above, about half of Massachusetts is underlain by bedrock, and much of that is outcroppings or near surficial. For example, in a recent soil survey for the proposed solar array at Gulf Road in Belchertown developed by Blue Wave Solar, 50% of the soil test pits showed bedrock at less than 9 feet from the surface.⁵ Of these, 75% found bedrock at less than 5 feet. Groundwater was also a problem. Groundwater was found in 56% of the pits, and in all but one at a depth of less than 4 feet.
 - a. The use of “screw-type, or post driven pilings,” as suggested by the statute, would be impractical, leaving only concrete ballasts or hammer drilling in the bedrock substrate as options. Based on the prohibitive cost of thousands of ballasts for a commercial array, the developer would choose to hammer drill the posts into the granite and concrete grout the holes. This is a problem. To decommission the facility and remove the array, the only option would be to cut the steel posts below grade, in turn producing large quantities of iron oxide (rust) that would infiltrate aquifers throughout central Massachusetts. Small amounts of rust are toxic to fish and reptiles, iron poisoning is debilitating to people, and rusty water would be objectionable.
 - b. This section of the draft states that soil-penetrating mounts should not be used “unless the need for such can be demonstrated.” The question here is: how will the need be demonstrated? This section gives no guidance with respect to the need for and importance of test pits and/or borings, and numbers and locations of both as delineated in the Massachusetts Stormwater Handbook. **Recommendation:** (1) Remove the phrase “unless the need for such can be demonstrated” and prohibit permanent anchor systems that must be cut when decommissioning, and (2) reinforce and restate Massachusetts Stormwater Handbook regulations concerning numbers and locations of test pits.
5. 225 CMR 20.05(5)(e)6f. The phrase reads: “no concrete...in the mounting area other than ballasts or other code required surfaces...” This requirement is impractical as noted above.
6. 225 CMR 20.05(5)(e)g. This article warns against installations that negatively impact soil and water conservation or stimulate erosion or water runoff. That salutary objective is masked by two problems that plague many proposed solar arrays, even those sited on modest slopes: (1) underestimates of future rainfall amounts due to global warming, and 2) stormwater projection models do not account for stormwater over frozen ground and freeze-thaw cycles, a primary cause of flooding in Western Massachusetts. **Recommendation:** Require developers to use realistic estimates of future rain events. Work with the researchers in the Northeast Climate Center at UMass Amherst to produce a range of likely 100-year water events over the next two decades, and then use the range to determine stormwater runoff amounts and velocities.
7. 225 CMR 20.05(5)(e)6i. This point states: “maintain vegetative cover to prevent soil erosion.” During construction on all but the smallest STGUs, the vegetative cover will be eliminated as a result of site preparation and, as noted above, soil quality will decline. Vegetative cover will not be preserved during installation and likely will take some years to recover, if ever. Recovery may be impossible on slopes that

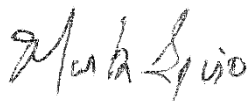
⁵ See the GZA report on test pits dug on December 18 and 19, 2018 for the proposed 0 Gulf Road solar array project.

exceed 10% or so, or on surficial or near-surficial bedrock, or on sites with high water tables, including water exposed through excavation. A succinct analysis of the problem is provided by Blue Wave Solar landscape architect Thomas Benjamin in his letter of December 10, 2018 to the Belchertown Planning Board: “Existing soils will be vulnerable to considerable compaction by equipment during solar array construction activities. Compaction will occur during site preparation activities, including removal of existing site vegetative cover and regrading. Further compaction will occur during erection of array tables, associated solar generation components, and establishing vehicular access-ways. Exposed, compacted soils will also be vulnerable to construction phase erosion.” **Recommendation:** Prohibit building on sites with slopes greater than 10%. On all sites require loamy soil additions to stimulate vegetative growth.

8. 225 CMR 20.05(5)(e)6 and 7. Good engineering design minimizes, but rarely eliminates, risk. It follows that failure to thoroughly identify and explore risks during design is an important contributor to systems failure. For this reason, engineering projects that potentially affect health and safety, including SMART projects, should require a risk or failure analysis in which practical risks are identified, impacts defined and quantified, probabilities assigned to risks, and mitigation measures specified. This process, typical of many major construction projects, gets all parties focused on potential problems and solutions early, and in turn, avoids the cyclical, repetitive cycle of design, analysis, risk identification, redesign, reanalysis, etc., that soaks up the time and resources of residents, planning boards, conservation commissions, courts, developers, and owners. Examples of risks associated with the proposed SMART program include: flooding due to underestimates of rainfall, flooding over frozen ground, fish kill due to entrained sediment, iron toxicity, panel wind damage, malicious destruction, inadequate battery storage, battery fires, transformer leakage, severed conduits, first responder triage, and inverter failure. By ensuring that remediation plans are in place, comprehensive risk assessments protect the program sponsor, developer, and most importantly, affected residents.
Recommendation: Require a risk analysis as a component of every SMART project, and broadly share it with residents, town officials, planning boards, and conservation commissions.
9. 225 CMR 20.05(5)(e)7. The Siting Criteria language does not address acceptable slopes, bedrock presence, and thin soil levels that may not have the capacity to transport adequate amounts of water from the site. They fail to address soil depth, bedrock depth, surficial water management, groundwater depth and management, array slope (within the fence), project slope (outside the fence but within project boundary), impact area slopes (outside the project boundary), aquifer distance, aquifer feeders, detention basin composition, volume, and location, infiltration basin composition, volume, and construction, among other variables. They completely fail to recognize the impact of trees on temperature mitigation, humidification, and surficial and groundwater mitigation. In summary, the Performance Standards and Guidelines read like a random collection of some variables that could affect DOER sites, but certainly not the comprehensive list of factors DOER and every applicant should consider when applying for the SMART program incentives. **Recommendation:** Reconsider the issues raised throughout this paper and partner with all concerned in developing an incentive program that makes sense to owners and developers while protecting the health and safety of community members

Thank you for the opportunity to share my thoughts about the proposed SMART program. I hope they were useful and I look forward to the next iteration.

Sincerely,



Mark K. Spiro