

**Loss of Open Space, Cultural Resources & Community Character
Caused by Industrial Ground-Mounted Solar Energy Systems in
Massachusetts**

Case Studies and a Call for Changing Solar Industry Subsidies

*Report By: Environment Watch of Southeastern Massachusetts
EnviroWatchMA.org*

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Report by: Environment Watch of Southeastern Massachusetts
Contributors: Meg Sheehan, Karen Vale, and Charl Heller

For more information:
www.EnviroWatchMA.org
info@envirowatchma.org

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I. Introduction

This report provides case studies that show how open space, community character, and tribal cultural resources are being destroyed or threatened by improperly sited by industrial-scale, ground-mounted (ISGM) solar installations.¹ State and local regulations need to be strengthened to ensure that this trend is reversed.

At a time when climate change is causing irreversible harm to the planet and the rate of species extinction is thought to be rising,² ISGM solar installations are causing further irreparable harm to our environment, including to unique ecosystems throughout the state. Clearing forestland and other important ecosystems in the name of “green solar energy” makes no sense. In addition, existing open space in Massachusetts often contains or supports tribal resources that are irreplaceable.

This report challenges the current methods of siting ISGM solar energy systems in Massachusetts. It provides case studies of eight ISGM solar projects that threaten or have already destroyed environmental or cultural resources, and highlights the voices of residents who have seen state and local laws side-stepped and ignored for improperly sited industrial energy systems. Some of the projects are built or are under construction, and some are currently embroiled in controversy or litigation.

Much of the focus of this report is on the Town of Plymouth, Massachusetts. Plymouth has untouched globally significant Pine Barrens, important cultural resources, as well as large undeveloped tracts of land that make it desirable to developers of ISGM systems. This has made Plymouth “ground zero” for ISGM solar development, much of which has threatened the environment and neighborhood character. In 2014, Mass Audubon ranked the Town of Plymouth #1 in the state with the greatest area of forestland lost to development between 2005 and 2013, with 400 acres lost.³ Plymouth has one of the highest rates of development. However, it also has the third highest occurrence of rare, threatened, and endangered species per square mile and the third largest area of globally

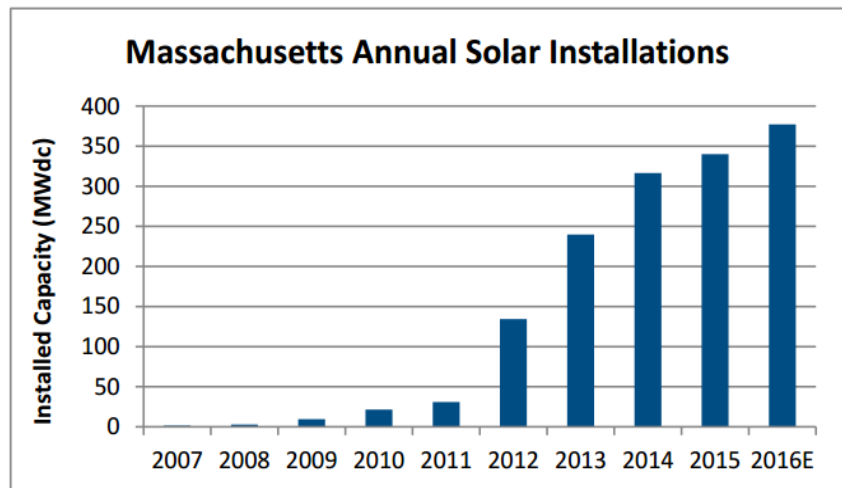
rare Pine Barrens in the eastern U.S.⁴ Yet ISGM solar projects have been built or are in the pipeline, which jeopardize these unique ecological and cultural resources.

The state's solar energy incentives should be changed so that ratepayer and taxpayer subsidies do not go into ISGM energy systems that destroy ecologically, socially, and culturally valuable lands. State and local laws should be enforced, and if need be, changed, to ensure that ISGM solar energy projects do not result in the loss of habitat, open space, and historic and cultural resources.

I. Background

Massachusetts ranks fourth in the U.S. for installed solar capacity. More than \$800 million was invested in solar statewide in 2015, resulting in the installation of 340 megawatts (MW) of electric capacity. This a 10% increase over the prior year, 2014, and installations are expected to increase. Most of the solar capacity in Massachusetts from commercial sources. Residential roof mounted solar installation are typically >15 kilowatts (kW), whereas ISGM solar installations can range from 500-6,000 kW.⁵

The obvious goal of solar energy is to reduce greenhouse gas (GHG) emissions that contribute



Solar Installations in Massachusetts since 2007 (source: www.seia.org).

to global warming and climate change. Properly sited solar energy systems such as those on rooftops and already disturbed lands (i.e., roadsides, landfills, parking lots) support this goal. On the other hand, clear-cutting forests, stripping vegetation, disturbing the natural topography, and destroying habitats that support a variety of rare and endangered species in order to install ISGM solar systems does not. Yet this is

happening often in Massachusetts due to poorly crafted solar incentives and weak regulations at the state and local levels.

In 1985, the state's Zoning Enabling Act was amended to address how municipalities may use zoning to control the use of land for solar installations. The state law says:

*"No zoning ordinance or by-law shall prohibit or unreasonably regulate the installation of solar energy systems or the building of structures that facilitate the collection of solar energy, except where necessary to protect the public health, safety or welfare."*⁶

This state statute has created confusion for municipalities. Prior to passing a solar bylaw in October 2016, Plymouth used the statute to exempt industrial scale solar projects from almost all zoning. About eighteen projects have been approved by local officials without proper application of local zoning laws. Three have been challenged in court.

Many Massachusetts towns have solar bylaws.⁷ The bylaws can be accessed on the Attorney General's website⁸ and are summarized in Appendix A. Some treat ISGM solar projects like other commercial/industrial uses and allow them to be sited only in commercial/industrial zones.

The state's Department of Energy Resources (DOER) is responsible for setting solar subsidies. It has a "Model Zoning for the Regulation of Solar Energy Systems" to help municipalities develop standards for ISGM projects. This covers a number of issues but does not provide specific enough guidance, as discussed below.

II. Siting Issues: Mass Audubon Recommendations

Mass Audubon recommends that the state's solar renewable energy credits eliminate incentives for solar energy systems that are sited on six categories of lands: certain wetlands, agricultural soils of prime or statewide importance, BioMap2 Core Habitat, including forest blocks greater than or equal to 500 acres, designated priority habitat of state-listed rare species, lands formally conserved through Article 97 status or

conservation restriction, and certain archeological sites. Until these recommendations are made into law by DOER and subsidies are denied, these lands are unprotected legally.

In all case studies reviewed for this report, there were no environmental impact studies carried out under the Massachusetts Environmental Policy Act (MEPA). Projects managed to avoid MEPA by evading certain thresholds and/or state permits, both of which would have required MEPA review. The state takes the position that its solar subsidies are not state financial assistance and therefore MEPA is not triggered. This loophole in MEPA allows ISGM solar projects to avoid environmental impact studies. In all the projects we reviewed, there was no comprehensive study of the impacts to environmental or cultural resources. These issues are addressed in more detail below.

III. Siting Issues: Negative Impacts of Misguided Solar Incentives

Federal and state programs that funnel ratepayer and taxpayer money to industrial solar energy systems without properly considering siting issues undermine decades old policies intended to protect the environment, historic and cultural resources, and local community character. Local, state, and federal agencies invest public funds in open space and biodiversity protection, yet when it comes to subsidies for ISGM solar projects these laws are essentially undermined or ignored. Examples of how this occurs are provided below.

A. Historic and Cultural Resources

ISGM solar installations have been proposed and/or constructed in areas that contain historic and cultural resources without proper regulatory review.⁹ The manner in which existing laws and policies are being enforced does not protect these resources from being destroyed by an ISGM solar project. Generally, any capital project receiving state or federal funding, licenses or permits are to be reviewed by the Massachusetts Historical Commission (MHC), which will assist in finding alternatives to avoid or mitigate potential damage to historic resources. MEPA could also protect these

resources if there is state funding or permits involved in the project. However, even though ISGM solar projects are not financially viable without state subsidies in the form of renewable energy tax credits and other state support, the Commonwealth takes the position that these financial incentives are not “state subsidies.” We are aware of no ISGM solar projects that have gone through MEPA or filed an environmental notification form (ENF) or environmental impact statement.

If an ISGM solar installation needs a federal permit, this may trigger the National Historic Preservation Act (NHPA), § 104 consultation process. This process requires the agency issuing the permit to consult with the Tribe that may have resources affected. General subsidies alone, however, do not trigger NHPA and most projects are designed to avoid federal permitting thus avoiding NHPA consultation. NHPA consultation usually requires some archeological survey with the goal of protecting cultural resources. In some cases, a Federal Clean Water Act general construction permit may be considered a federal permit that would trigger NHPA consultation between the U.S. Environmental Protection Agency (EPA) and the affected tribal nation.

Some Massachusetts communities have local preservation ordinances or local historic districts that require local approval for new construction visible from a public way but we have seen no case where these laws have been effective at preventing an ISGM solar system from destroying historic and/or cultural resources.

Currently, three ISGM solar installations in Massachusetts are known to threaten Tribal resources: Sun Edison/Plymouth, Lake Street Development Partners/Shutesbury, and Borrego/Freetown. In Shutesbury, a lawsuit was filed in August 2016 against developers and town planners for proposing an ISGM solar project on possible Tribal burial sites (learn more about the Lake Street Development Partners/Shutesbury project in Section V.E.). In Freetown, the Borrego project is planned for an area known to have thousands of Tribal ceremonial and burial sites. The Aquinnah Wampanoag is the primary tribe is trying to trigger a consultation process through EPA to have the land formally reviewed and mapped before construction. Other tribes, such as the Narragansett, Mashpee

Wampanoag, and the state recognized Pokanokett and Massachuseuk have also expressed concern. Similarly, in Plymouth, when informed of a potential disturbance of “historic or cultural resources important to the tribe” due to the Sun Edison’s ISGM solar project, the Mashpee Wampanoag Tribe filed a Consultation Response Form in October 2016. Yet, this letter is unlikely to result in an archeological survey to protect the resources.¹⁰

B. Ecology and Biodiversity

Massachusetts has many areas with high levels of biodiversity and rare species, including in Plymouth County. The actual legal protections for these species and their habitats is minimal. The Massachusetts’ Natural Heritage and Endangered Species Program (NHESP), which implements the Massachusetts Endangered Species Act, G.L. c. 131, provides some level of review for sites designated as “Priority Habitats” or “Estimated Habitats,”¹¹ but generally this does not stop the habitat from being irreversibly altered. Once an endangered species is identified, the state merely issues a “take permit” or requests “mitigation” as in the case of the Solar City project in Shirley. This is not the equivalent of protecting the habitat.

Unless a habitat is listed with NHESP, there is no review or protection. Relatively few areas in Massachusetts have habitat protection under MESA since is politically unpopular for the agency to designate private land due to the perception of taking away private property rights. For most sites, a developer is able to get a letter from NHESP saying that the site is not listed and there are no listed species present – and this is usually because there has been no biological survey to determine whether species are present or not. In other words, no one ever looks. There is no requirement that a developer conduct a biological survey to see if species protected under NHESP are present on the site.

The NHESP’s BioMap2¹² is a tool intended to aid in the conservation of Massachusetts’ biodiversity at multiple scales: (species, ecosystem, and landscape levels), especially in the face of climate change impacts. BioMap2 identifies 2.1 million acres across the state that are critical to biodiversity.¹³ These areas are placed in two categories: Core Habitat and Critical Natural Landscape. Core Habitat includes areas important to the survival of species of conservation concern and intact ecosystems.¹⁴ Critical Natural Landscape includes larger areas that are important to ecological processes, disturbances, and wide-ranging species.¹⁵ Unless and until DOER changes the rules for subsidies, the BioMap2 designation provides no legal protection. An ISGM solar developer is free to clearcut, remove soil, and destroy habitats. For example, the Renewable Energy Development Partners/Plymouth ISGM solar installation was constructed on BioMap Core Habitat and Critical Natural Landscape, see Section V.A.1. below.

Massachusetts Department of Environmental Protection (MassDEP) has statewide maps and



related guidance documents to identify “Habitat of Potential Regional or Statewide Importance” and to support wetland protection review. The maps and guidance are intended to help evaluate the potential impact of projects to wildlife habitat for species that are not state-listed and to help municipal Conservation Commissions and developers know what evaluations and reviews should be done. These maps and guidance documents do not protect such lands and do not require the developer to do anything.

Until DOER eliminates subsidies, developers can ignore Biomap2 areas and MassDEP guidance.

Solar can pose direct mortality risks to wildlife mainly during construction activities, but cases of avian mortality due to impact trauma and associated predation related to the solar installation have also been documented.¹⁶ Solar can also cause indirect impacts due to habitat alteration during construction and maintenance activities. Sites that are cleared of vegetation and graded could have a major impact in particular.¹⁷ Solar developers are supposed to comply with the Massachusetts Endangered Species Act (MESA) or the Federal Endangered Species Act (ESA), if they are to adversely affect state or federally listed endangered or threatened species.¹⁸

DOER'S model solar bylaw suggests that municipalities without current site plan review regulations with language pertaining to NHESP identified habitats or Important Wildlife Habitat identified by MassDEP could include language to protect these areas.¹⁹ However, even when there is NHESP designated habitat, local site plan review does nothing to stop destruction, as in the case where Solar City/Shirley has cleared about 24 acres of NHESP habitat for a more than 7,000 solar panel project.

C. Property Values and Community Character

Improperly sited ISGM solar installations may harm property values and irreversibly alter the character of an area. Common sense dictates that the construction and installation of ISGM solar projects in certain locations such as residential neighborhoods, as is occurring in Plymouth, may reduce the value of nearby homes. According to Mass Audubon, while town planning sometimes aims to reduce density to maintain rural appeal, large-scale development and loopholes in zoning laws leads to land change that threatens community character.²⁰ This includes ISGM solar.

One study found that 70% of people believe that large-scale solar installations will decrease property values.²¹ Some studies show that other types of power production facilities reduce property values, with one study finding 3-7% decreases in housing values within two miles of power plants and even larger decreases within 1 mile and for large-capacity plants.²²

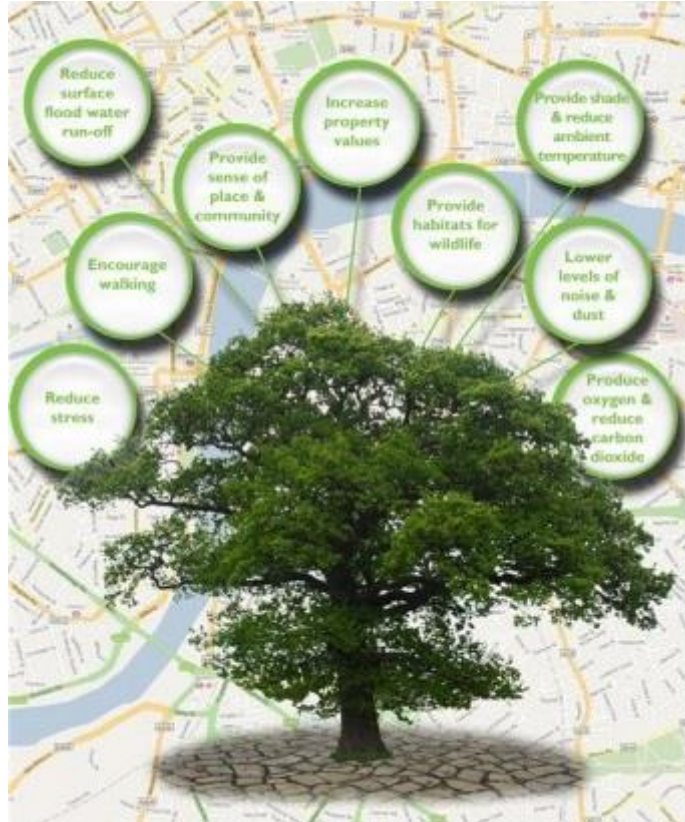
Trees are an amenity that make a positive contribution to property values.²³ When trees are cleared for an abutting ISGM solar installation, the loss of that amenity is likely to reduce values. This aerial photo of the REDP site in a Plymouth rural residential district shows before and after clear-cuts, which are supposed to be within 300 feet of residences.



D. Deforestation and Impacts to Soils

Trees are important to public and environmental health, property values, air and water quality, reducing floodwaters, and reducing GHG in the atmosphere by acting as a carbon sink.²⁴ Mature trees sequester more carbon than younger trees.²⁵ In addition, soils sequester carbon.²⁶

ISGM solar projects that cut down trees, and remove topsoil and vegetation result in habitat loss and fragmentation.²⁷ This can result in declines in species population density and species richness, and major changes to community composition, species interactions, and ecosystem functioning.²⁸ Clear-cutting also disturbs soils, releasing CO₂ to the atmosphere and contributing to climate change.²⁹



Trees have numerous benefits for people and wildlife.

(Source: Woodland Trust)

Siting Preferences

Where a solar facility is sited, as well as placement on the site once selected, is an important consideration, particularly in regard to large-scale ground mounted facilities. DOER strongly discourages locations that result in significant loss of land and natural resources, including farm and forest land, and encourages rooftop siting, as well as locations in industrial and commercial districts, or on vacant, disturbed land. Significant tree cutting is problematic because of the important water management, cooling, and climate benefits trees provide.

This “siting preference” however, has not prevented clearcuts and does not have any binding legal effect.

The construction and operation of ISGM solar systems may also impact wetlands and other water resources. In at least one case, the MassDEP has approved the installation and operation of a ISGM solar project on Zone 1 and 2 watershed protection lands (See Section V.B.).³⁰

E. Ambient Temperature

Clearing a forest reduces the amount of shade that trees would otherwise provide. This can lead to warming on a microclimate level, especially the temperature of air, soils, and nearby streams.³¹ It can also increase energy use for nearby homes in the summer (for cooling due to loss of shade) and winter (for heating due to loss of trees serving as wind barriers).³²

IV. Operating & Decommissioning Issues

The operation and decommissioning of ISGM solar installations raises issues for the community and environment. This is especially true where the ISGM solar project has been built on public lands, or lands near rivers, wetlands and that are known priority habitat for protected species. Issues include releases of hazardous materials, stormwater runoff, and water pollution.

DOER's model zoning bylaw helps municipalities develop standards for ISGM projects, including requirements related to abandonment and decommissioning.³³

A. Risks from Hazardous Materials

ISGM solar panels are typically made of silicon and covered by protective glass. Some panels may contain hazardous materials such as cadmium telluride (CdTe), copper indium diselenide (CIS), copper-indium-gallium-diselenide, cadmium-telluride, and gallium arsenide (GaAs).^{34,35} These materials are in solid form and don't mix with water or air, so releases to ground or air is not a major concern. If the panels are not handled or disposed of properly, especially if large solar farms are abandoned and not decommissioned properly, public health and environmental impacts could become a problem.³⁶

The components of an ISGM solar project include transformers and current inverters, commercial scale batteries, distribution or collector lines, circuit breakers and other power production components.

State and federal regulations regulate the use and disposal of certain industrial chemicals, but typically, the types and quantities of industrial chemicals used by ISGM solar projects are typically not disclosed to the public during the permitting process.

Some solar panels contain components that are considered hazardous waste. When this is the case, Massachusetts' regulations require disposal be "properly managed" under state hazardous waste regulations.³⁷ Under these regulations, the burden to determine whether panels are hazardous lies with the owner, by checking either with the manufacturer or through toxicity tests. Non-hazardous panels are regulated as solid waste and panels with hazardous components are regulated as hazardous waste. In some cases, panels with minimal hazardous components can be exempt from state hazardous waste regulations.

Developers of ISGM solar projects should be required to disclose to the public the types and quantities of chemicals and hazardous wastes used in the operation and maintenance of the electric generating equipment. Permits should ensure proper onsite management of industrial chemicals and other hazardous materials.

B. Stormwater Runoff and Groundwater Pollution

ISGM solar projects that clear forested lands, remove vegetation and/or regrade existing topography are typically required to comply with state and federal laws for stormwater runoff during construction and during the life of the project. In Massachusetts, developers do not need to obtain a "general construction" permit from EPA under the Clean Water Act National Pollutant Discharge Elimination System (NPDES) program until two weeks before construction begins. This means that stormwater plans are often not available for local officials and citizens to review until construction is about to begin. Once the ISGM solar installation is built, stormwater must be managed on site. Developers should be required to use Low Impact Development (LID) methods for stormwater controls, but are usually not required to do so.

When ISGM solar projects are built on watershed protection lands, as in the case of Solar City/Shirley (Section V.B.), the removal of forests and topsoil means that the natural vegetation can no longer filter rainwater that sinks into the soil and recharges the drinking water aquifer. This is a concern particular since ISGM solar installations also use industrial chemicals and hazardous materials in operations.

C. Herbicides and Fertilizers

ISGM solar installations require the control and management of unwanted vegetation under and around the panels and on access roads. Use of chemicals can threaten water supplies, as well as native flora and fauna. Yet few, if any, permits require non-toxic or organic forms of controlling and managing vegetation.

D. Decommissioning ISGM Solar Projects

Solar panels typically last about 20 to 30 years. Developers should be legally responsible for decommissioning ISGM solar projects, and to the extent possible, site restoration. The public should be considered a third party beneficiary of any lease agreement between a solar developer and the landowner, whether it is a municipality or private owner. Without strict provisions in permits, regulations, or leases, there is no guarantee that the public will not be burdened with the costs of decommissioning solar facilities where owners are bankrupt or not held legally responsible.

Developers should be required to recycle solar panels at the end of their life cycle, via either a lease, permit, or regulation. The solar industry is not required to recycle its products by state or federal regulations although some companies recycle voluntarily and some solar panel manufacturers offer recycling options.³⁸ Decommissioning should include removal of the facility itself (including panels), breaking up concrete foundations, removal of access roads, and re-contouring and revegetating the land according to strict standards.³⁹ Where total site restoration is not possible, particularly when public lands

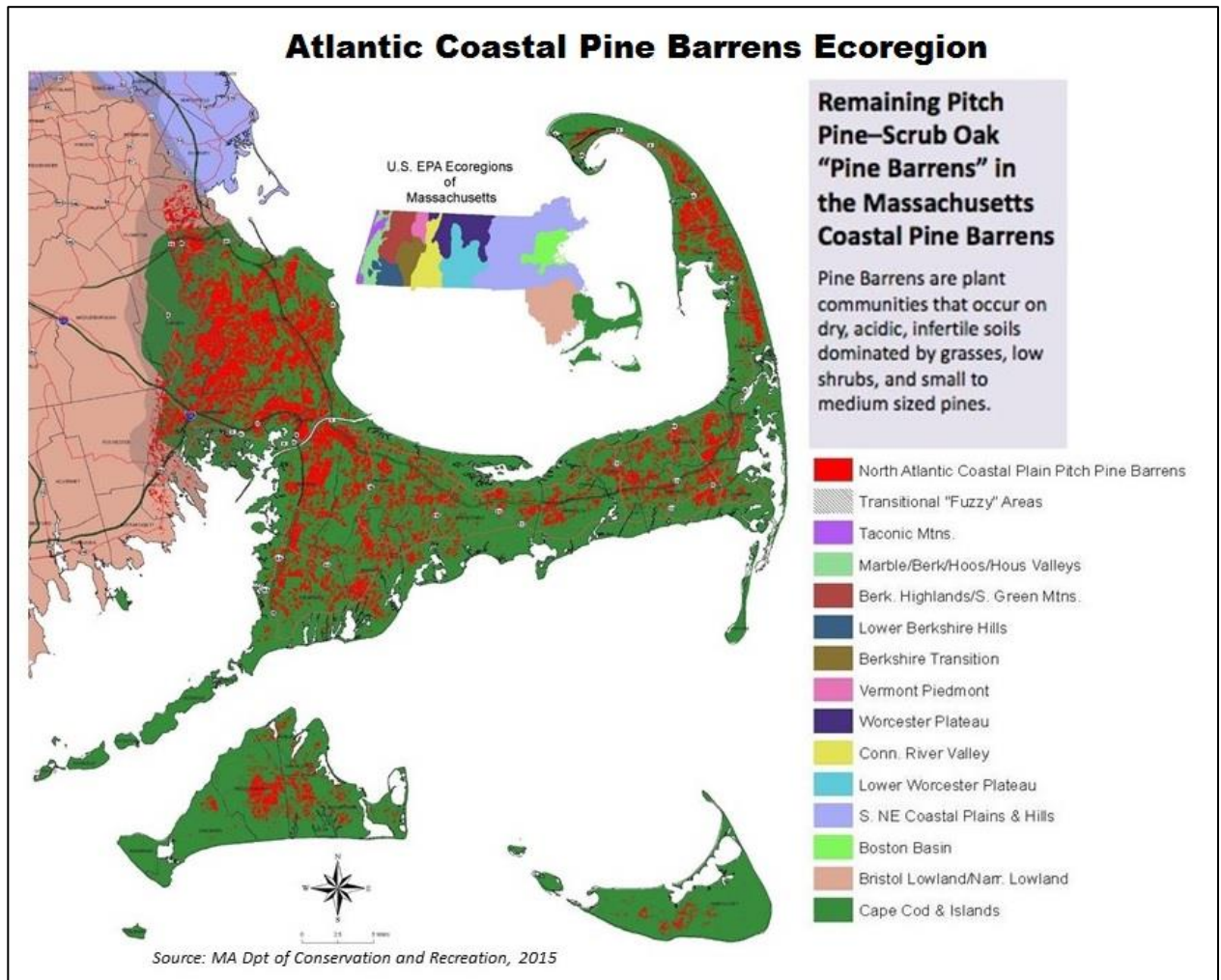
or watershed protection lands are used, solar developers should provide for off-site mitigation. This could take the form of ensuring land conservation in another nearby area.

V. Examples of Improperly Sited ISGM Solar Projects

A. Town of Plymouth

There have been 15 ISGM solar projects either completed or underway in Plymouth as of the date of this report. These projects range from approximately 1 to 41 acres in size. At least half of these have been sited on undeveloped land, meaning that nearly 100 acres or more of forests and areas of vegetated ground cover have been destroyed. At least nine ISGM solar projects have been put on land zoned rural residential, even though ISGM solar installations are commercial/industrial uses that are prohibited in the residential zoning district.⁴⁰

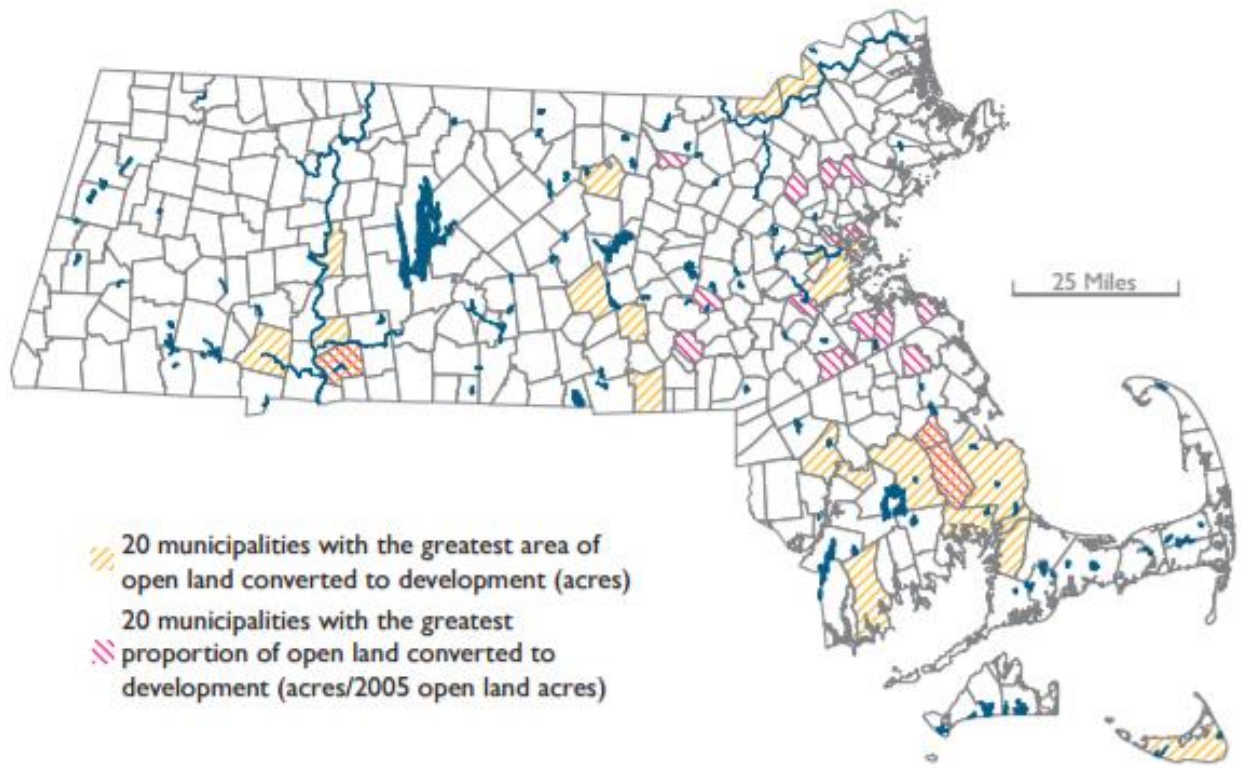
Plymouth is the state's largest municipality area-wise and is home to Myles Standish State Forest, a town forest, and several parks, beaches and recreation areas. Two of the world's largest remaining Pine Barrens,⁴¹ a globally unique ecosystem, are found in southeast Massachusetts, including in Plymouth. The pine barrens forest communities are made of pitch pine and scrub oak woodlands, are home to rare species, and help protect freshwater resources.



In terms of loss of open space to development, Plymouth ranks at the top -- #1 in the state with 300 acres lost from 2005 to 2013. Furthermore, in terms of forest conversion Plymouth ranks #1 in the state with 400 acres lost during the same time frame. With many of Plymouth's ISGM solar projects occurring after 2013, the number of acres lost are likely now much higher.

Solar Projects in Plymouth, Massachusetts, as of November 2016.

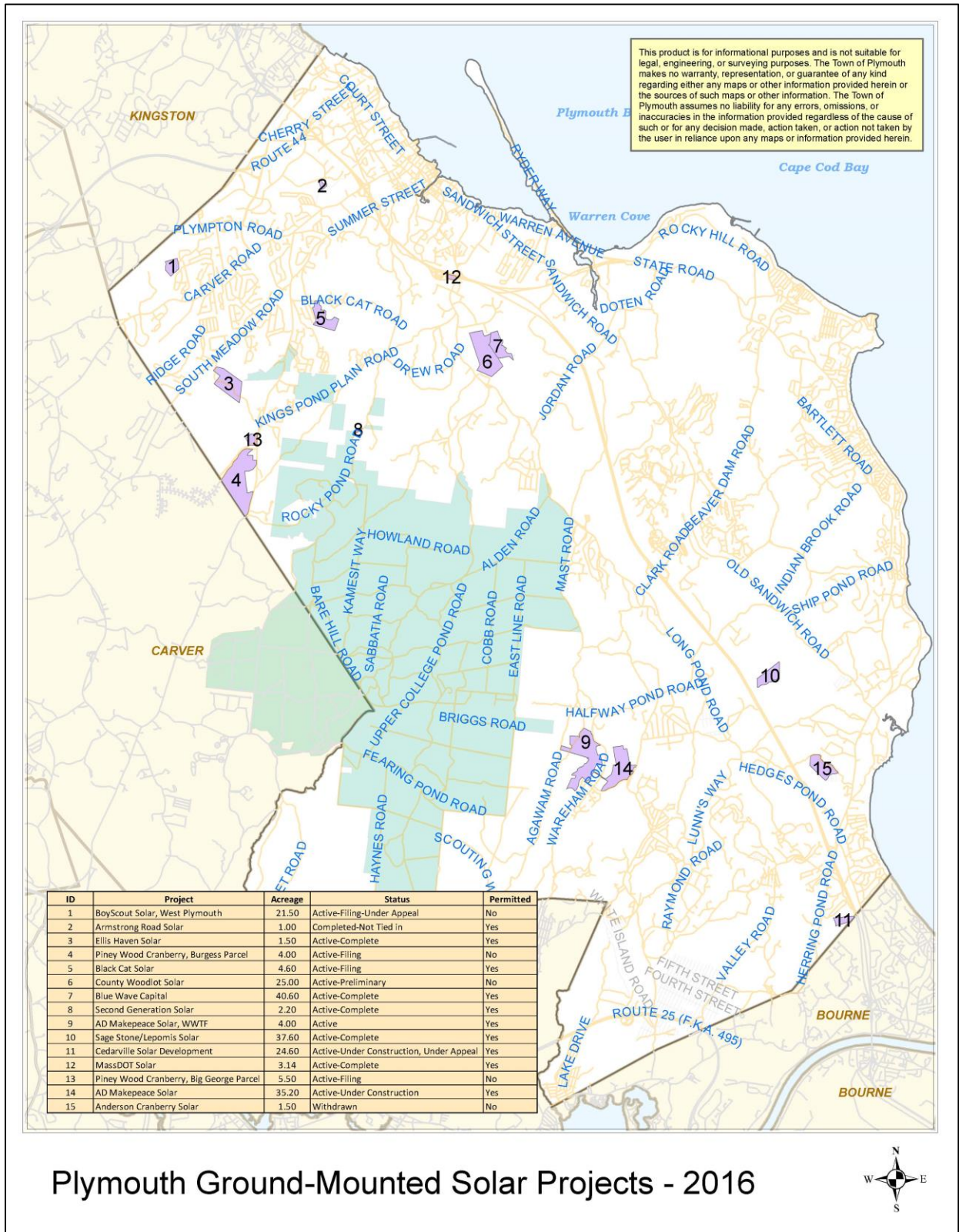
Project	Location	ParcelID	Zoning (note)	Applicant	Developer	Size (DC)	Size (AC)	Acreage	Status	Land Condition
AD Makepeace Solar	Redbrook Project off River Run	115-000-008-000	?	ADM	Borrego Solar	5.55MW		35.2	Active-Under Construction	Wooded Vegetation
AD Makepeace Solar, WWTF	Redbrook Project off River Run WWTF	116-000-000A-011	RR (Mixed Use)	ADM	Renewable Energy Development Partners		500kW	4	Active	Previously Cleared
Armstrong Road Solar	Off Armstrong Rd	101-000-053-002	LI (Land-IND)	Environmental & Energy Solutions, Inc.	Environmental & Energy Solutions, Inc.	650kW		1	Active-Complete	Cleared
Black Cat Solar	Off Billington St./Black Cat Rd.	090-000-017-005	RR (Mixed Use)	Borrego Solar, Eric Pontiff	Borrego Solar	1.3MW		4.6	Active-Filing	Cleared
Blue Wave Capital	Camelot Industrial Park	083-000-019E-000	RR (Ind/Res)	Blue Wave Capital	Sun Edison	5.35MW	4.5MW	40.6	Active-Complete	Array Installed
Cedarville Solar Development	Off Herring Pond Rd	056-000-057A-000	RR (Unbuildable)	Renewable Energy Development Partners	Renewable Energy Development Partners	3MW		24.6	Active-Under Construction	Portions Cleared
County Woodlot Solar	Off Long Pond Rd/Caleb Dr	088-000-054-000	RR (County)	Plymouth County	SOLECT	2-4MW		25	Active-Preliminary	Vegetated/Meadow
Ellis Haven Solar	Off South Meadow Rd	097-000-006-007	AP	Ellis Haven Inc. / Carrey Family Trust	Ellis Haven Inc. / Carrey Family Trust	500kW		1.5	Active-Complete	Array Installed
Sage Stone/Lepomis Solar	Off Old Sandwich Rd	062-000-001-020	RR (Elect Plant)	Lepomis Solar	EDF Renewable Energy	6MW		37.6	Active-Complete	Array Installed
Second Generation Solar	Off Rocky Pond Rd	092-000-013A-000	RR (Elect Plant)	Red Oak Farm, LLC, Joseph Hamilburg		650kW		2.2	Active-Complete	Array Installed
MassDOT Solar	Off Rte 3, Exit 5	Mass Hwy Rte 3	?	Mass DOT	Amereso	562kW		3.14	Active-Complete	Array Installed
BoyScout Solar, West Plymouth	Off Kristin Rd. and Parting Ways	107-000-024A-000	RR (Char-Rec)	Annawan Council	Sun Edison	5.8MW	4MW	21.5	Active- Filing	Wooded Vegetation
Piney Wood Cranberry, Burgess Parcel	969 Federal Furnace Rd, West Plymouth	099-000-001C-000	RR (Mixed Use)	Renewable Energy Development Partners	Renewable Energy Development Partners	662kW	500kW	4	Active-Filing	Portions Cleared
Piney Wood Cranberry, Big George Parcel	Off Federal Furnace Rd, West Plymouth	097-000-010C-000	?	Renewable Energy Development Partners	Renewable Energy Development Partners	1.25MW	1.0MW	5.5	Active-Filing	Cleared
1229 State Rd. Solar	Off State Rd., Kathy Mann Property	072-000-004-006			Borrego Solar		2MW	15	Preliminary	Wooded Vegetation
Glynn Electric Solar	Behind BBC, Off State Rd.	054-005-002B-011		Glynn Electric	Glynn Electric				Preliminary	Cleared
Manomet Land Fill Solar	On capped land fill	074-000-001-000		Green Harbor Energy	Green Harbor Energy				Preliminary	Cleared/Landfill
Cedarville Land Fill Solar	On capped land fill	055-000-022A-000		Green Harbor Energy	Green Harbor Energy				Preliminary	Cleared/Landfill
Jordan Rd. Solar	Off Jordan Rd.			??	??				Preliminary	??
							Total	225.44		



Open land conversion in Mass. 2005-2013; Plymouth ranks #1 at 300 acres lost.⁴²

Plymouth's Master Plan seeks to control sprawl, protect the environment, and preserve the character of the Town. It states, "Plymouth's diverse natural and built landscapes include historic sites, village settlements, rural landscapes, forests, coastline, ponds, streams, wetlands, and cranberry bogs. These landscapes define Plymouth's character and must be preserved." The natural resources that should to be protected by Plymouth's Master Plan include undeveloped open land, outstanding biodiversity, the Pine Barrens, hiking trails and the natural scenic features in every part of Town.

ISGM Solar Projects in Plymouth, Massachusetts, 2016.



Plymouth Ground-Mounted Solar Projects - 2016



This destruction of important environmental resources is supported by Plymouth's track record of fast-tracking ISGM solar projects is underscored by a misplaced focus on PILOT (payment in lieu of taxes) payments and the fact that zoning laws are being ignored and side-stepped.

As in many towns, emphasis is placed on the revenue that can be generated through a PILOT agreement or real estate taxes over the relatively short term. This often takes priority over ensuring the preserving the character of rural residential districts and the natural and cultural resources of the town and enforcing the Bylaw. Yet, PILOT payments and real estate tax income for the town are not permanent, lasting only for about 20 years (about the lifespan of the solar installation). However, once natural and cultural resources are destroyed, they are gone forever.

1. Renewable Energy Development Partners/Plymouth (under construction)

Renewable Energy Development Partners' (REDP) ISGM solar installation has resulted in the clearcut of about 25 acres for more than 11,000 solar panels, associated inverters, cabling, lights, and an access road. The project is currently under construction.

According to Gene Lafond, a Plymouth resident and abutter to the REDP project, *"The project destroys trees and the environment while making a false profit. This solar field will not generate enough energy to be profitable. The only reason this destruction is permitted is that the state, through our taxes, subsidizes solar fields. The town authorized the destruction of 24 acres of pristine woodland and habitat for a promise of a total of \$160,000 spread out over 20 years. However, this could go away if the state subsidies go away. Then the town is left with an environmental nightmare."*



Site of REDP's ISGM Solar Installation, before the clearing of forestland and after. Photo: Google Earth

This occurred with no MEPA review and despite the fact that the land is designated as:

- An Area of Critical Environmental Concern (ACEC) under state law⁴³
- BioMap2 Core Habitat and Critical Natural Landscape⁴⁴
- Upland Forest/ Prime Forested land⁴⁵
- Zoned Rural Residential under the Town Bylaw, which prohibits commercial/industrial uses

The site was never inventoried or studied by NHESP, therefore it was unable to say that the site was subject to protection under MESA. The state provided a routine “sign off” letter and the landscape was irreversibly destroyed.

Efforts by local citizens to get municipal zoning officials to enforce local zoning to prohibit the project from the Rural Residential district were unsuccessful.⁴⁶ Legal action challenging the project initiated in July 2016 and the matter is still pending.

2. BlueWave LLC/Plymouth (completed)

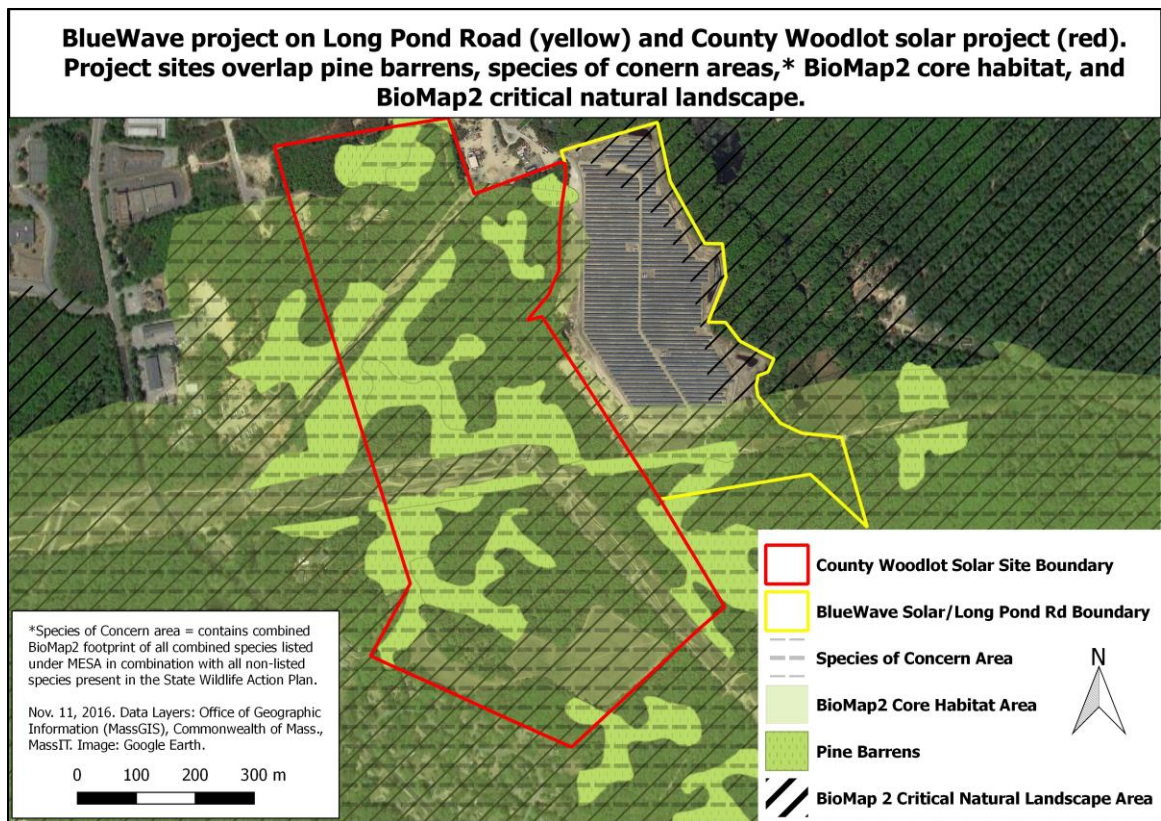
In 2014, BlueWave Capital installed a 5-MW solar project (17,820 solar panels) in a rural residential zoning district on about 25 acres of land that had been mined by Plymouth Sand and Gravel company. The project was completed in 2014. Under the terms of a zoning permit issued in 1996, the land was supposed to be used for a cranberry bog and residence, and restored to its former condition following the mining operation.⁴⁷ The conversion to a commercial/industrial use was allowed by local zoning officials without a special permit or other public review process.



*Blue Wave Solar Project on Raffaele Road in Plymouth. Photo and additional project information:
www.bluewaverenewables.com*

3. Blue Wave LLC/Kingstown Sand and Gravel/Plymouth (permits granted, proposed)

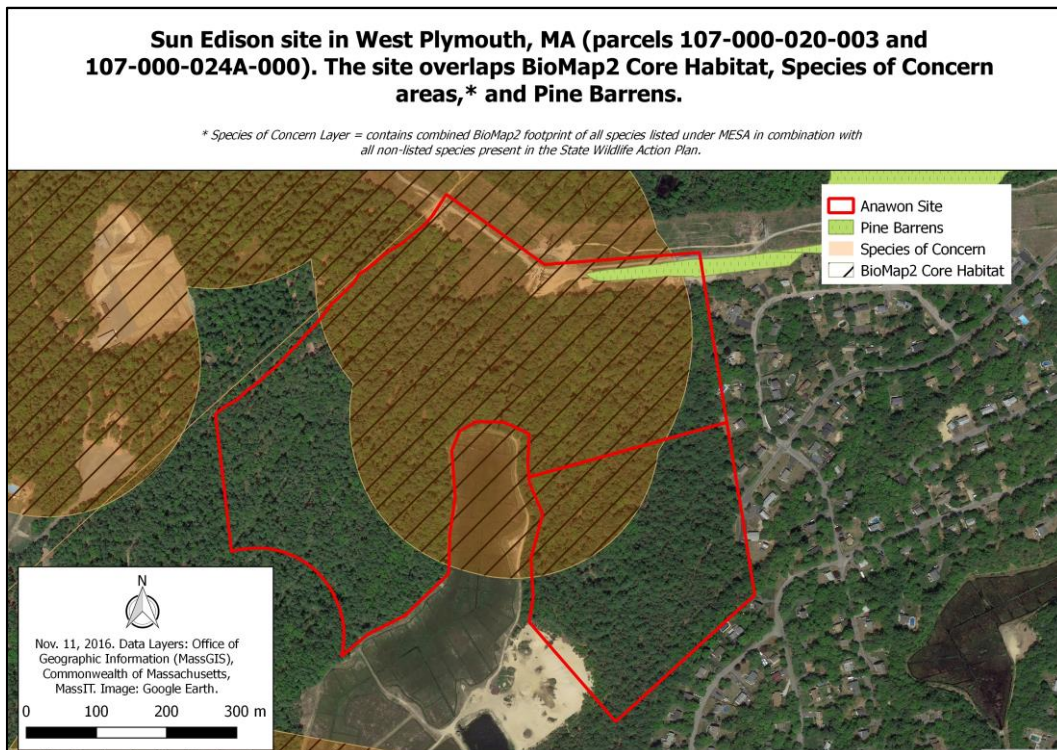
The Town of Plymouth has approved a forest clearcut and mining operation for a proposed ISGM solar project that Blue Wave is allegedly building.⁴⁸ The site is located on public land and is known as the County Wood Lot. It is held by the County of Plymouth in trust for the benefit of the inhabitants and has been used for public recreation since the early 1900s. The Town’s zoning approval has been challenged in court and the case is pending. The site is part of the Atlantic Coastal Pine Barrens ecosystem that supports 37 types of plants and animals protected under MESA.⁴⁹ Testimony in the case states, “Clearing the County Woodlot and developing an industrial solar facility there will irreparably alter the landscape by turning what is now a globally rare Pine Barrens into a treeless solar facility.”⁵⁰



4. Sun Edison LLC/Plymouth (permits granted, proposed)

In February 2016, Plymouth issued an 'as of right' zoning permit to Sun Edison for an ISGM solar installation of about 4-MW and 17,400 solar panels. The proposed site is within a tract of about 75 acres including wetlands that have been used for open space, recreation and a Boy Scout camp since the 1960s. It is zoned rural residential. About 24 acres of mature forest will be clearcut, vegetation will be removed, and the site will be re-graded. It is likely this site has never been tilled for agriculture. There has been no estimation of the amount of CO2 and other greenhouse gases that will be released into the atmosphere by clearcutting the forest and disturbing the soil. The project will be 100 to 200 feet from nearby residential homes. SunEdison, a global company headquartered in the U.S., was a business unit of Monsanto Company until 1989.

There was no environmental impact report or MEPA review, and due to the misapplication of zoning laws, no legal notice to interested persons of the zoning application. The project was able to get the routine sign off from NHESP despite its proximity to BioMap2 habitat.



Following a citizen appeal of a zoning permit for the project, the Town's Zoning Board of Appeals (ZBA) ruled 3-2 that the project violates local zoning because it is a commercial/industrial use in a residential district. Since four votes from the ZBA were need to overturn the zoning permit, the permit was upheld. The decision has been appealed in Massachusetts Land Court.⁵¹ The case alleges that the project violates zoning laws and the Town of Plymouth Master Plan, which aims to control sprawl, protect the environment, and preserve the character of the town.

In October 2016, the Masphee Wampaoag Tribe informed Sun Edison and the Town that the project "has the potential to have 'adverse effects' to historic or cultural resources important to our tribe" and "[t]he inventories of known sites show that this area has been utilized over multiple time periods as far back as the Paleo time period. Where there are burials, there is a high likely hood [sic] for habitation and or village sites to be found nearby." To date, Sun Edison has not taken action on the matter.

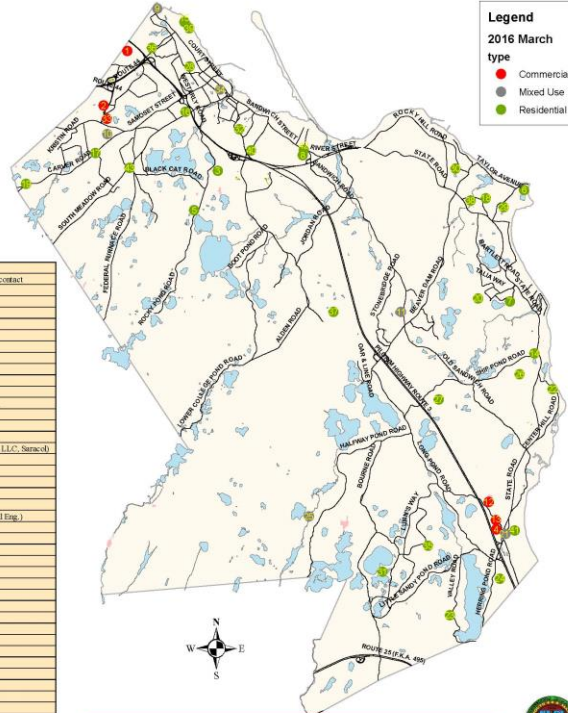
As alleged in the legal challenges to this project, the SunEdison ISGM solar installation violates Plymouth's Master Plan and zoning laws, and harms nearby residents' interests in natural resource, cultural, historic, aesthetic, open space and scenic qualities of the town and their neighborhood. A solar energy system with these negative impacts is contrary to the goals of a solar energy incentive program.

5. Future Outlook in Plymouth

The Planning Department's town-wide development map (shown below) does not include ISGM solar projects. These solar installations should be included; without them, it is misleading to town boards and residents regarding the extent of development under way.

March 2016 Current Development

Prepared by Office of Planning & Development
Town of Plymouth, Massachusetts



ID	Project	Summary	Status	Type	Case	Developer
1	Prestige Way	Undetermined commercial uses	Road work started, s/d	COM	B530	Bill Shaw, Associated Eng. primary contract
2	Colony Place	865,000 SF retail	650,000 SF built	COM	BOA #3182, more	Saxon Partners, Gary Durrum
3	Oakland Hill	Open Space RDD, 16 lots	Under construction, 8 lots remain	RES	B524	Barry Tassman
4	Coakley Commons	175,000 SF retail	Under appeal	COM	P-9069	Coakley Hill Housing LLC
5	Watercourse Place	Open Space RDD, 54 lots	Under construction, 4 homes remaining	RES	B475	Bob Burpee (RHH Development)
6	Rosemont Realty Trust	Open Space VOSD, 3 lots	2 lots remain	RES	B563	Rosemont family
7	Hilda's Estates	11 new dwellings	Under construction, 9 lots remain	RES	B566	Nick Sennet
8	Branthall Village	Open Space VOSD, 24 lots	Approved	RES	B598	Branthall Village LLC
9	Country Park	Phase 1, 150 rental/40,000 SF retail	Phase 1 approved, under design	MIX	B547	Jammy Bros. Jon and Joe
10	Country Crescent	80,000 SF retail, 35,000 SF office	Under construction	MIX	BOA #2946	Mike Vogel, Mike Cahill
11	Phyllis	2003 units and Village center	1,800 homes built	MIX	B437	Pine Hill LLC
12	Hedges Pond Road	4 lot commercial	Under construction	COM	B554	Economic Development Foundation
13	Cedarhill Park	64 lot commercial subdivision	Road constructed, one lot built	COM	B512	Rockland Trust
14	Trunk Road Settlement	Open Space VOSD, 4 lots	Under construction	RES	B-994	Aquaticus Dredges
15	Harbour View	42 condos	Seating completion	RES	BOA #3065	Cladstone Dvr, Corp.
16	Lighthouse Cove	125 (55) housing units	No construction, s/d	RES	BOA #3110, B519	Coll & Roulforth (Lighthouse Cove LLC, Sunco)
17	Stone Gate Farm	53 multi-fam. lots, 30 retail	No construction, s/d	RES	B510	Brad Culling & One Doodle
18	Barrett Pond Pasture	40B, 75 age-restricted lots	Phase 1 Under Construction	RES	BOA #3232	Robert Friedland
19	Turn Pines	40B, 16 units	Approved	RES	BOA #3329	Freeman Realty Association
20	Sewall Woods	40B, 240 unit condos	Site work started, s/d	RES	BOA #3281	Triangle Property & Coll
21	British Beer Company	15,000 SF retail and 25-30 res	Approved, s/d	MIX	BOA #3376	Doug Freeman
22	Bayview	13 lots	Road built, s/d, no homes	RES	B436	Center Hill Ltd. Partnership (Quantal Eng.)
23	Valley View Preserve	Open Space RDD, 10 lots	Under construction	RES	B522	Michael Goodman
24	Waldenwith Estates	384 lot subdivision	Approved, under construction	RES	B474, BOA #3049	Brad Culling
25	River Run	1,100+ units (90,000 SF comm)	Under construction building on 116 lots	MIX	B543	AD MidSpace
26	Ship Pond Hill	51 lot subdivision	Under construction, 14 homes built	RES	B426	Tom Fitzgerald
27	Fox Hollow (The Trails)	Open Space RDD, 52 lots	Under construction, 12 homes built	RES	B569	Wells & Col. Cheval LLC
28	Sherman Woods	Open Space VOSD, 14 condos	Under construction, 4 homes built	RES	B536	Greg Gibbe Spectrum Homes
29	Nestle Down	14 lot subdivision	Constructed, 3 lots remain	RES	B515	Karl Anderson
30	Blackboard Farm	Open Space VOSD, 1 lot	s/d	RES	B571	Roger Randall
31	Country Park	Open Space VOSD, 8 lot	Under construction, 1 home built	RES	B576	Abelrite Builders
32	Oak Hollow	Open Space VOSD, 10 lot	Under construction, 2 lots remain	RES	B562	Phil Owen
33	Commerce Way	2 medical office buildings	Site prepared, 1 building constructed	COM	BOA #3709	Henry Stout (Admiral Properties)
34	HOZ construction	New Town Municipal Facility	Under construction	RES	B580	Town Manager's Office
35	Arbor Hill Estates	Open Space VOSD, 29 lots	Under construction, 3 homes completed	RES	B580	Abelrite Builders
36	Bitters Hill	Open Space VOSD, 32 units	Under construction	RES	B569	Tamman Construction
37	Waverly Oaks	Open Space RDD, 50 lot	Under construction	RES	B581	Long Pond Golf Corp.
38	153 State Road	Open Space VOSD, 23 units	Approved	RES	B589	191 State Road LLC
39	Atlantic Point	Open Space VOSD	Approved	RES	B599	Michael Goodman
40	Cherry Street	Open Space VOSD, 56 units	Approved	RES	B609	Franked Hill Developer LLC
41	Indian Drive	Open Space VOSD, 5 lots	Approved	RES	B597	Newtown Dublin Drive Realty Trust
42	Chilton Lane	Open Space VOSD, 3 new home lots	Under construction	RES	B592	E.J. Poirier
43	Village at South Meadow	Open Space VOSD, 6 home lots	Under construction	RES	B537	Gerard Poirier

A new solar bylaw passed at Plymouth's Town Meeting in fall 2016.⁵² While it provides maximum size limits, and screening and abutter notification requirements, it should be strengthened. It allows, "by right," ISGM solar installations in all zoned districts, including residential areas. It does not prohibit, or require a special permit, for ISGM solar projects in residential neighborhoods. It also does not address the segmentation of projects by developers. Given the size limitation set by the new bylaw, developers should not be allowed to install multiple projects or parts of projects on contiguous lots. This type of segmentation reduces the official project size and helps developers avoid MEPA and other important regulations. The acreage of the entire project should be summed and apply.

The buffer requirements in the bylaw are inadequate. Buffers should be proportional to the size of the project. In other words, the bigger the project, the bigger the buffer in order to better protect residents and nearby property values. The bylaw also provides that the clearing of trees and other vegetation be limited to those necessary for the construction, operation, and maintenance of the project. Instead, ISGM solar projects

should only be allowed on already cleared land and no clearing of trees and vegetation should be allowed at all. Further, full project plans should be required from the developer prior to approval and permit issuance, such as plans including transmissions lines, cement pads, and transformers. As written, the bylaw does not require this.

Five revisions have been proposed to the town's solar bylaw for spring 2017 Town Meeting.⁵³ The revisions are:

1. Reduce the maximum size of arrays in residential areas from 15 to 5 acres.
2. Prohibit ground mounted photovoltaic arrays in areas already designated by the state as prime habitat or areas of critical environmental concern.
3. Increase buffers for 1 to 2 megawatt systems from 75 to 150 feet.
4. Increase buffers in larger systems from 150 to 200 feet.
5. Require the arrays owner to notify abutters 14 days before a required site plan review.

The Planning Board voted to support four of the five amendments (#2-5 above). The amendments will now be reviewed by the Finance Committee and the Board of Selectmen, which will vote on whether to recommend its passage by Town Meeting. At the spring Town Meeting, the amendments will require a 2/3 majority for passage.

B. Solar City/Town of Shirley

Despite local opposition, in early 2016, Solar City began construction of a 995.28 kW DC ISGM solar system (approximately 7,600 solar panels) on about 24 acres of forested land owned by the Town of Shirley and the Shirley Water district. The land was clearcut, trees and vegetation removed, and the site graded. The project was allowed despite the site:

- Being zoned almost all residential under the Town zoning law which prohibits commercial uses;
- Including almost 12 acres deeded to the Town for “protection of water resources and other compatible uses including conservation and recreation,”⁵⁴ but is now surrounded by a chain link fence;
- being protected by Article 97 of the State Constitution;
- designated as Zones 1 and 2 for aquifer/drinking water protection under state law and the local bylaw;
- designated as rare species habitat under MESA by NHESP;
- abuts an ecologically significant stream for native brook trout, designated as cold water fish resource by the Massachusetts Department of Fish and Game; and
- designated by the town as conservation land in the Town’s Master and Open Space and Recreation Plans.

According to Betsy Colburn, a Shirley resident and Aquatic Ecologist at Harvard Forest, in a January 2016 Boston Globe article, *“I support solar energy and have it at home. I support balancing the town’s books, and I support good government. I think there are good places and bad places for solar farms. As an aquatic scientist and concerned citizen, I consider that before replacing public forests on water supply lands in residentially zoned areas with commercial, industrial-scale, renewable energy production, the town must provide the most careful, deliberate, and comprehensive consideration and impose adequate protections. Shirley has strong bylaws, but they are worthless if not implemented. The risks are too high to short-circuit the process.”*⁵⁵

The Town’s approval of the project has been challenged in a citizen-led lawsuit, filed January 2015, that is pending in state Land Court.

C. Borrego Solar Systems LLC/Town of Freetown

Borrego Solar Systems has proposed a 2.79-MW ISGM solar installation on an approximately 17-acre site on private property. The project has been approved by the town’s Conservation Commission and the Planning Board with restrictions.

Freetown is one of the oldest communities in the country and is situated along old Native American trails to Boston. The solar site is part a larger, 500-acre site known as Rocky Woods located in Freetown and Lakeville and has no development or roads. The 500-acre site contains many cultural resources, primarily Tribal ceremonial and burial sites. There are thought to be around 1,000 ceremonial sites on the 500 acres as well as many known burials. More than ten Traditional Cultural Properties (TCPs) are located on the solar project site, although official mapping of them has yet to occur. There are likely other cultural resources located on the 17-acre project site; however, no official mapping or review of the land has been carried out so far.

Mapping could occur as part of the federal consultation process under Section 106 of the National Historical Preservation Act, once a permit is requested from EPA from the project proponent. The Aquinnah Wampanoag tribe is trying to trigger a consultation process through EPA to have the land formally reviewed and mapped before construction. Other tribes, such as the Narragansett, Mashpee Wampanoag, and the state recognized Pokanokett and Massachussek have all expressed concern.

If EPA determines any Federal Tribe has concerns about the project, then the agency is obligated to conduct consultations to resolve concerns prior to issuing a permit. Usually this involves the EPA, or other agency, requiring the project proponent to protect the TCPs, or, if protection is not feasible, mitigation is ordered.

Not only would the mapping likely occur at the developer's expense, but also the solar project would have to be put on hold until the consultation process is completed. It would also mean that representatives from the aggrieved Tribe(s) could be on-site to oversee some construction activities once the project was to begin again.

D. BlueWave LLC/ Town of Oak Bluffs

On Martha's Vineyard, the Oak Bluffs Water District, along with developer BlueWave and project owner SunEdison, proposed to clear approximately 10 acres of forestland to build an ISGM solar installation. The installation would be on land owned by the Water District

and directly abuts the Manuel F. Correllus State Forest, an aquifer protection area. There are three public wells in the vicinity of the project. While it is not the first solar array on the island, it is the first project that would result in the clearcutting of mature forestland.

The Oak Bluffs Conservation Commission, along with forest experts, have not been in support of the project and the Martha's Vineyard Commission recently denied it after the Commission's Land Use Planning Subcommittee voted to not recommend the project.

The Director of Harvard Forest stated that, "*the proposition to destroy forests, which are one of nature's most efficient solar collectors, with a manufactured solar collector is counterintuitive and counterproductive.*" The groups say that clearing trees to install solar only undermines benefits of renewable solar energy production.

MassDEP and NHESP have already conditionally approved the project, despite the area being close to public wells and providing habitat for rare species.

Article 97 of the State Constitution may legally protect the land since it is designated as permanently protected in order to protect the water supply. If Article 97 does apply, additional review would be required as well as a two-thirds majority vote by the state legislature and Governor Baker's approval.

E. Lake Street Development Partners/Town of Shutesbury

Lake Street Development Partners is developing a 6-MW solar installation on a 30-acre tract of land owned by W.D. Cows, the state's largest forest landowner. The ISGM solar project is proposed on what could be Tribal burials. Shutesbury is a small rural town in Franklin County, approximately 80 miles west of Boston.

Shutesbury's Planning Board approved a special permit for the project in June 2016. Conditions accompanying the permit included that the developer hire an archaeologist to review the property to determine if Tribal burial sites or sacred stone structures are present.

Lake Street Developer's archeological report found no Tribal burials or structures on the site. A separate archaeological report commissioned by the Town of Shutesbury's Planning Board concurred with these findings; however, it disagreed with and criticized some of the methodology in the developer's report.

Local residents including Tribal members have challenged the town's archeological report. Part of the challenge is because Tribal Historic Preservation Officers were not allowed to walk the property. As a result, five individuals filed a federal civil rights lawsuit in August 2016 against the developer and town planners for proposing and approving the project. The lawsuit aims to stop construction until Tribal Historic Preservation Officers can determine if the site is sacred land. The matter is pending in federal court.

VI. Conclusion

The Massachusetts DOER should ensure that ratepayer and taxpayer subsidies for industrial solar energy systems do not undermine federal, state, and local policies intended to protect natural and cultural resources. The recommendations of Mass Audubon and other groups should be adopted to avoid the loss of even more open space that contributes to the environmental, cultural, and economic vitality of our state.

Towns like Plymouth should pass and strengthen local zoning bylaws to ensure the maximum protection for our cultural, historic, and environmental resources.

References

- ¹ ISGM solar projects are different from residential rooftop solar, solar panels on commercial or public buildings, and widespread installation of panels on public infrastructure such as utility poles.
- ² Scientists at the U.N. Convention on Biological Diversity have estimates that up to 150 species are lost each day, which could be as much as 10% per decade. <<https://www.cbd.int/doc/speech/2007/sp-2007-05-22-es-en.pdf>>
- ³ Mass Audubon. June 2014. Losing ground: Planning for resilience. 5th Ed. <http://www.massaudubon.org/content/download/12561/197565/file/MassAudubon_LosingGround_5_FINAL_lores.pdf>

- ⁴ Town of Plymouth. March 2010. Open space and recreation plan: 2009 update. <http://www.plymouth-ma.gov/sites/plymouthma/files/uploads/2010_plan.pdf>
- ⁵ DOER. July 2013. Task 1 Report: Evaluation of current solar costs and needed incentive levels across market segments. 74 pp. <<http://www.mass.gov/eea/docs/doer/rps-aps/doer-post-400-task-1.pdf>>
- ⁶ Provisions of G.L. c. 40A, §3
- ⁷ For an overview of how the Courts treat the bylaws, see, *Briggs v. Zoning Board of Appeals of Marion*, 22 LCR 45 (2014)
- ⁸ Office of Mass. Attorney General. Municipal Law Unit (MLU) Decision Lookup <<http://www.mlu.ago.state.ma.us/>>
- ⁹ Wescott K. February 2013. Impacts of utility-scale solar development on cultural resources Argonne National Laboratory, DOE. <<http://www.bia.gov/cs/groups/xieed/documents/document/idc1-021612.pdf>>
- ¹⁰ Mand, F. Nov. 3, 2016. Mashpee Wampanoag Tribe wants monitoring of West Plymouth solar project. Wicked Local Plymouth. Wicked Local Plymouth. <<http://plymouth.wickedlocal.com/news/20161103/mashpee-wampanoag-tribe-wants-monitoring-of-west-plymouth-solar-project>>
- ¹¹ “Priority Habitats” are areas inhabited by state-listed species. Solar projects that will alter ≥ 2 acres of Priority Habitat are subject to review, and developers are required to file a MESA form, project plans, and map of the site. NHESP determines whether the project would result in a “take” of state-listed species and whether a project redesign or scale down is needed, and whether a project should move forward at all. “Estimated Habitats” are areas that fall within the range of state-listed species. These areas are especially important to protected species in and around wetlands. If the project is proposed on Estimated Habitat and the local Conservation Commission requires it, the developer must file a Notice of Intent (NOI) under the Wetlands Protection Act and submit copies of the NOI, project plans and a topographical map to NHESP; Mass. DOER, Mass. DEP, Mass. CEC. June 2015. Questions & answers: Ground mounted solar photovoltaic systems. 24 pp.
- ¹² Woolsey, H., A. Finton, J. DeNormandie. 2010. BioMap2: Conserving the Biodiversity of Massachusetts in a Changing World. MA Department of Fish and Game/Natural Heritage & Endangered Species Program and the Nature Conservancy/Massachusetts Program.
- ¹³ Of which 1.2 million acres are not protected.
- ¹⁴ Including habitats for rare, vulnerable, or uncommon species; priority natural communities; high quality wetlands and aquatic/coastal habitats; and intact forest ecosystems.
- ¹⁵ For example, adjacent uplands that buffer wetland, aquatic, and coastal habitats.
- ¹⁶ Kagan RA, et al. June 2014. Avian mortality at solar energy facilities in southern California: A preliminary analysis. National Fish and Wildlife Forensics Laboratory. 28 pp.
- ¹⁷ Badichek G. 2015. Resolving conflicts between endangered species conservation and renewable energy siting: Wiggle room for renewables? *Consilience: The Journal of Sustainable Development*. 14(2): 1-24.
- ¹⁸ *ibid.* 17
- ¹⁹ MA EOEEA. Dec. 2014. Model Zoning for the Regulation of Solar Energy Systems. <<http://www.mass.gov/eea/docs/doer/green-communities/grant-program/model-solar-zoning.pdf>>
- ²⁰ Mass Audubon. May 2009. Losing Ground: Beyond the footprint. Version 4. 32 pp. <http://www.massaudubon.org/content/download/8600/149718/file/LosingGround_web.pdf>
- ²¹ Carlisle JE. Aug. 2015. Public attitudes regarding large-scale solar energy development in the U.S. *Renewable and Sustainable Energy Reviews* 48: 835-847.
- ²² Davis LW. 2011. The effect of power plants on local housing values and rents. *The Review of Economics and Statistics*. 93(4): 1391-1402.
- ²³ PA Dpt of Conservation and Natural Resources. June 2010. Pennsylvania statewide forest resource assessment. 210 pp.; Holmes TP, et al. 2006. Exotic forest insects and residential property values. *Agricultural and Resource Economics Review*. 35(1): 155-166.
- ²⁴ For an overview and related references, see: PA Dpt of Conservation and Natural Resources. June 2010. Pennsylvania statewide forest resource assessment. 210 pp.
- ²⁵ Stephenson NL, Das AJ, Condit R, et al. March 2014. Rate of tree carbon accumulation increases continuously with tree size. *Nature*. 507: 90-93.

- ²⁶ Lacroix EM, Petrenko CL, and Friedland AJ. 2016. Evidence for losses from strongly bound SOM pools after clear cutting in a northern hardwood forest. *Soil Science*: 181(5): 202-207.
- ²⁷ Habitat fragmentation is when habitat loss occurs by the division of large, continuous habitats into smaller patches of lower total area, isolated from each other.
- ²⁸ Didham RK. 2010. *Ecological Consequences of Habitat Fragmentation*. eLS.
- ²⁹ *Ibid.* 26.
- ³⁰ MA DOER, MA DEP, MA Clean Energy Center. June 2015. *Clean Energy Results, Questions & Answers, Ground-mounted Solar Photovoltaic Systems*. 24 pp.
- ³¹ Kimmins JPH. 1999. *Balancing Act: Environmental issues in forestry*. UBC Press, Vancouver BC. Page 91; Ice GC. Nov. 3, 1999. *Streamflow and water quality: What does the science show about clearcutting in western Oregon?* Presented at *Clearcutting in Western Oregon: What Does the Science Show?*, Oregon State University, Corvallis, OR.
- ³² Kuhns M. 2017. *Planting trees for energy conservation: The right tree in the right place*. Utah State University.
- ³³ *Ibid.* 19.
- ³⁴ MA DOER, Mass. DEP, Mass. CEC. June 2015. *Questions & answers: Ground mounted solar photovoltaic systems*. 24 pp.
- ³⁵ UCS. 2013. *Environmental impacts of solar power*. <http://www.ucsusa.org/clean_energy/our-energy-choices/renewable-energy/environmental-impacts-solar-power.html#bf-toc-2>
- ³⁶ *Ibid.* 34 and 35.
- ³⁷ MA hazardous waste regulations, 310 CMR 30.000
- ³⁸ *Ibid.* 34.
- ³⁹ *Ibid.* 34.
- ⁴⁰ On October 20, 2016, the Plymouth Zoning Board of Appeals voted 3-2 that the Sun Edison solar project was an industrial/commercial use that was prohibited in the rural residential zoning district where it is proposed. CITE ZBA Decision, Case No. See, Plymouth Bylaw, § 205-40, prohibits commercial and industrial uses in the rural residential district.
- ⁴¹ “Pine barrens” is an umbrella terms for several types of plant communities, but all include two defining tree types: pitch pine and scrub oak.⁴¹ Pine barrens occur on harsh, sandy sites with dry, acidic and infertile soils – they are rare and found only in scattered locations from New Jersey to Maine.
- ⁴² *Ibid.* 3
- ⁴³ c. 21A, § 7; Massachusetts Land Court Case 15 MISC 000481, *Heller Aff.* ¶ 20, 21.
- ⁴⁴ Massachusetts Land Court Case 15 MISC 000481. *Heller Affidavit* ¶ 22.
- ⁴⁵ Massachusetts Land Court Case 15 MISC 000481, *Heller Affidavit* ¶ 24, Exhibit 5.
- ⁴⁶ Under G.L. c. 40A, Section 7 and the Plymouth Zoning Bylaw.
- ⁴⁷ ZBA Case No. 2712, 1996 Decision.
- ⁴⁸ ZBA Decision in Case No. 3795R, 2015.
- ⁴⁹ Massachusetts Land Court Case 15 MISC 000481, *Heller Affidavit*
- ⁵⁰ Massachusetts Land Court Case 15 MISC 000481, *Heller Affidavit* ¶ 27.
- ⁵¹ Massachusetts Land Court Case 15 MISC 000481
- ⁵² Article 26. Plymouth Solar Bylaw, approved at Town Meeting fall 2016. <<http://envirowatchma.org/wp-content/uploads/Article26-1.pdf>>
- ⁵³ Mand F. Dec. 20, 2016. *Solar bylaw: Pushback against changes, Planning Board supports most. Wicked Local Plymouth*. < <http://plymouth.wickedlocal.com/news/20161220/solar-bylaw-pushback-against-changes-planning-board-supports-most>>
- ⁵⁴ See, Deed from J&A Realty Trust to Town of Shirley, Middlesex Book 20862, Page 284.
- ⁵⁵ Boston Globe. Jan. 15, 2016. *The argument: Should proposed Shirley solar project go forward now?* <<https://www.bostonglobe.com/metro/regionals/west/2016/01/15/the-argument-should-proposed-shirley-solar-project-forward-now/1sm5DDLhKx5CK1fUavKqgl/story.html>>