SOLAR BLUEPRINT

Town of Lincoln, Massachusetts
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prepared by

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I. EXECUTIVE SUMMARY

Lincoln was designated a Massachusetts Green Community in 2010. This is a municipal commitment to reduce greenhouse gas emissions through the implementation of energy efficiency measures in Town-owned buildings, facilities, and vehicular fleets; and through the increased use of renewable energy sources.

This report assesses the opportunities for solar photovoltaic (PV) arrays on Town-owned land in Lincoln. Installation of new PV arrays will increase the percentage of renewable energy consumed to power municipal operations, and potentially decrease the total cost of municipal electricity.

In 2015 the Board of Selectmen established the **Solar PV Working Group** with representatives from the Green Energy Committee, Planning Board, Conservation Commission, Board of Selectmen, and Town Administration. This Group met through 2016 to review the Town's solar priorities and opportunities. Solar Design Associates (SDA) of Harvard, MA, a solar engineering and design firm, was hired to perform technical, siting, and feasibility analyses on 25 potential sites in Lincoln.

Our solar siting process included the identification of municipal, school, and institutional buildings and properties, and involved an assessment of technical feasibility, potential configurations, and required infrastructure needed to support solar installations. Ratings from (A-C) are based on power output, technical complexity, investment levels, implementation time frame, permitting/approval process, impacts to Lincoln's rural landscape vistas, and ability to help meet our solar energy objectives.

<u>Goals:</u>

- Local generation of 1 - 2 MW of power to offset a major portion of municipal demand
- Focus on the built environment first for lowest cost, easiest to implement options
- Able to be completed in 1-3 years
- Project supported by a State-approved solar development partner

<u>Sites Considered:</u>

- Municipal buildings and land (10 properties)
- Lincoln Schools Campus (13 buildings and parking lots)
- Institutional land (2 properties)

The Working Group reviewed 25 potential sites that presented a range of locations and infrastructure on which to evaluate the siting of solar facilities. These included parking lots, roofs of both historic and contemporary buildings, the Landfill site, pastures, private institutional properties, and the buildings and parking lots of the School Campus. All sites are already owned by the Town or institutions so there are no direct land costs. The costs of system development and operations are borne by the developer/operator and the Town would either get a reduced cost of electrical energy or a ground lease fee for the contract period.

After the detailed analysis the recommendation is that the Town pursue two near-term "A" rated sites now as projects for implementation in 1 -3 years. This will hopefully enable Lincoln to take advantage of the State's proposed Solar Incentive Program (SIP). These projects will provide substantial solar energy to the grid and help stabilize or offset the Town's electrical budget. Both solar PV installations will be highly visible to residents and the general public, demonstrating our commitment to green energy solutions that provide an array of benefits to the Town and, ultimately, the global environment.

- A roof-mounted solar installation at the **Public Safety Building**, with up to 58.6 kW of annual solar generation.

- A ground-mounted solar installation on the **Landfill**, which has the potential to support up to ~1.4 MW in annual solar generation, the equivalent of approximately 50% of the amount of energy consumed by our Town buildings.

The School Campus also has four buildings and one parking area that are ranked as "A" sites so this complex is a solar priority for the Town. Substantial changes will occur in the coming years at the Lincoln Public Schools, therefore it is not fiscally responsible to pursue PV at the Ballfield Road sites at this time. However, Town Boards, School Administration, and residents should plan for and strongly advocate for future installation of solar PV at the Schools as we move towards implementation of this project.

ADDITIONAL KEY FINDINGS OF THE SOLAR PV WORKING GROUP:

1. The Town should take advantage of opportunities to locate solar PV on buildings and parking lots (i.e., the "built environment") before considering installations on open land, unless acquired for this purpose. Conservation lands are not an option.

2. Solar economics are complicated and depend on various Federal and State tax incentives, and this environment is fluid. Incentives are decreasing so time is of the essence. (See Section VI: Financial Incentives for more detailed information.)

3. Solar Power Purchase Agreements (PPAs) are a cost-effective opportunity for municipalities to purchase solar-PV-generated electricity.

4. While removing trees to install solar PV systems may be considered environmentally neutral or even positive, the Town is unlikely to support opportunities that require substantial tree removal.

5. Future discussion needs to occur concerning the Town's overall energy conservation targets to provide a better planning framework for green energy initiatives.

6. We acknowledge that we use large amounts of energy with an associated large carbon footprint, and therefore have an obligation to do our part locally to reduce this footprint in the coming years.

II. BACKGROUND: GREENING LINCOLN

Lincoln is a conservation-minded community that has, through a number of votes and initiatives, made clear its desires to pursue strategies that decrease the Town's consumption of fossil fuels, reduce its greenhouse gas emissions, and lower its carbon footprint (see Table 1).

Table 1. — A brief history of renewable energy commitments in the Town of Lincoln.

2006	The Lincoln Green Energy Technology Committee was formed by the Board of Selectmen to identify energy-related technologies to reduce municipal energy use.
2008	At Town Meeting, a measure for new construction and major rehab energy performance criteria with a net-zero fossil fuel target by 2030 was adopted.
2009	Lincoln's Long Range Master Plan includes many references to energy efficiency, alternative energy, and conserving resources, and includes a recommendation to identify residents to lead the development of a climate action plan. Lincoln has implemented many of the energy efficiency recommendations.
2010	At Town Meeting, a measure passed to adopt the Massachusetts Green Community designation criteria, which includes a 20% energy-use reduction target for all municipal buildings against a 2008 baseline, a two-acre solar PV array at Minuteman Regional High School, and related measures.
2010	Lincoln was officially designated as a Massachusetts Green Community, one of the first 17 towns approved to participate. The program has since supported more than $750,000 worth of energy-efficiency investments in Lincoln's facilities and vehicular fleet.
2011	A Greening Lincoln Initiative engaged more than 200 residents who attended forums, provided email contacts, and pledged to reduce their energy consumption.
2012	New zoning bylaws were approved to encourage solar PV installation investments.
2012	Lincoln, Sudbury, and Wayland joined forces to participate in Solarize Mass, a residential solar PV initiative program that supported the installation of 32 new small-scale solar PV systems in Lincoln through 2015.
2015	A citizens' petition led to a Town vote urging Town boards to consider the effects that their decisions will have on climate.
2016	Another citizens' petition urged the Town to divest from its investments in fossil fuels.
2016	The Green Energy Committee launched the new Lincoln Energy Challenge with the goal of signing up 300 households to receive free home energy assessments and subsequent energy efficiency upgrades and options for on-site renewable energy installations.

GREENING LINCOLN: NEXT STEPS

After thoughtful deliberation, the Town identified two immediate opportunities to generate electricity from solar PV that will help reduce the municipal expense of utility power for Town operations. Hopefully these opportunities will be expanded over time. This report documents the findings from the Solar PV Working Group that confirms these opportunities are appropriate for Lincoln.

These recommendations follow 10 years of municipal solar PV investigations in Lincoln. The Green Energy Technology Committee (now Green Energy Committee) first presented potential municipal solar PV installations in 2007 at Town Meeting. Recommendations included a small 2.5-kW demonstration installation at Lincoln's Transfer Station and a 25-kW installation on the kindergarten wing of the Smith School.

In 2012, the Town's gas and electricity quasi-public supply vendor, Power Options, announced a solar PV initiative for Massachusetts cities and towns. The Green Energy Technology Committee's explorations eventually led to the installation of a solar PV parking lot canopy at Lincoln-Sudbury Regional High School.

Later in 2012, Lincoln joined a regional solar procurement effort led by the Metropolitan Area Planning Council (MAPC). The vendor selected for this initiative, BlueWave Capital, LLC, submitted two solar PV system proposals for the Town's consideration, one at the capped Landfill and one at the Public Safety Building. Both proposals include an agreement between BlueWave and the Town to generate renewable energy and to help lower the Town's electricity bill.

III. FEDERAL, STATE, AND LOCAL RENEWABLE ENERGY TARGETS

Federal policy for renewable energy is to supply 30% of the energy consumption by executive departments and agencies from renewable resources by 2025.

State policy for renewable energy is more ambitious than the Federal government's. Massachusetts proposes to have a 30% supply of renewable energy in all state buildings by 2020.[1]

Lincoln does not have a policy for renewable energy, but the Town's decision to pursue municipal solar PV aligns closely with these federal and state goals and is consistent with the Town's Green Community designation.

With the latest state renewable energy credits (SRECs) expiring in early 2017, Lincoln will not be ready in time to qualify for the current SREC incentive program and will need to wait for the State Legislature to draft the next series of State Solar PV incentives.

[1] Commonwealth of Massachusetts Department of Energy Resources "Leading by Example Program" brochure. From http://www.mass.gov/eea/docs/eea/lbe/lbe-brochure.pdf, accessed October 14, 2016.

IV. SOLAR OPTIONS AND SITING CONSIDERATIONS

SOLAR OPTIONS

There are two basic types of solar PV installations: ground-mounted and roof-mounted. Roof-mounted solar is a good option in situations where there is enough space and sunlight atop a building to be a productive host for solar panels. The alternative is to use ground-mounted solar, which is best situated in clearings without shading by trees or other obstacles. Solar panels absorb and convert sunlight into electric current, which is typically connected to the power grid.

In Lincoln's case, SDA looked at rooftop arrays, parking canopies, ground-mounted arrays and dual-use ground-mounted arrays for 25 sites. SDA also considered the relative prices and production capabilities of the different sites (see Financial and Policy considerations report for further detail).

The capped Landfill and Codman Community Farms (CCF) pasture sites offer two locations where ground-mounted solar arrays could be developed. This type of array is an efficient way to install a large amount of solar energy capacity with a low installation price, if it can be installed in a compact layout. A compact layout is feasible at the Landfill, but not at CCF. The density of the desired panel coverage and field shading makes this solar installation incompatible with ongoing agricultural use of the pasture. A small dual-use demonstration array may be feasible at CCF at a later date. This design would be elevated to allow livestock to graze beneath it.

The viability of a rooftop system is directly dependent upon both the age and infrastructure of a roof. Typically, the roof should be brand new or at the end of its life, in which case the roof would be replaced before a PV system is installed. This is to align the life cycle of the roof with that of the solar array, most likely at least 20 years. Rooftop arrays offer a variety of benefits, including: utilizing available space on the built environment, elevating panels above the tree canopy, and providing an alternative to using valuable open fields.

SDA also investigated the potential for installation of parking canopies in Lincoln. This type of PV installation takes advantage of underutilized real estate, as well as provides shade and coverage from rain and snow for vehicles. Parking canopies cost significantly more than both rooftop and ground-mounted solar arrays. This cost is even higher in the Northeast where engineered structural supports are needed to accommodate the snow that may accumulate on the canopy. A parking canopy may be a technically feasible option but a cost/benefit analysis is necessary to determine a specific project's viability.

SITE ANALYSIS

With assistance from SDA, the Solar PV Working Group investigated, reviewed, and ranked each of the sites by using a letter grade (A–C). See Table 2 for a list of sites and a summary of the findings. Detailed analyses of each site can be found in Appendices D–BB.

Ratings are based on projected power output, technical complexity/ease of installation, investment levels, implementation time frame, permitting/approval process, impacts to Lincoln's rural landscape vistas, stake-holder concerns, and ability to help meet our solar energy objectives. All of the solar designs are subject to change as these designs and power projections are estimates; only when a full shade analysis and detailed layout is created can an accurate power projection be provided.

Although it is our understanding that Commonwealth school building funds may not be used to support solar initiatives, a Town investment in solar would be consistent with our "Green Community" status and should make financial sense.

Table 2. — Solar siting options for the Town of Lincoln by site rank

Landfill	1376	A
Public Safety building	58.6	A
School building 1	82.1	A
School building 2	62.7	A
School building 3	91.2	A
School building 7	21.4	A
School parking C	144.3	A
Department of Public Works	74.9	B
Rural Land Foundation parking canopy	188	B
School building 4	25.7	B
School building 6	94.1	B
School building 8	51.9	B
School parking B	102.6	B
School parking A	188	B/C
Codman Community Farms main building	48.4	C
Codman Community Farms outbuilding 1	7.8	C
Codman Community Farms outbuilding 2	10.7	C
Codman Community Farms outbuilding 3	22.1	C
Codman Community Farms pasture	496.3	C
deCordova Sculpture Park parking canopy	432	C
School building 10	27.4	C
School building 5	44.5	C
School building 9	27.4	C
Town commuter lot	206	C
Water treatment plant	23.7	C

RECOMMENDED NEAR-TERM SOLAR INSTALLATIONS

Using the technical analysis of each site, the Solar PV Working Group found that two sites stood out as the best locations to start building municipal solar capacity to work towards meeting green energy targets: the Public Safety Building and the Landfill. These sites are controlled by Lincoln's municipal government and could be permitted and installed in the shortest period of time. A summary of the advantages of these two sites is offered in Table 3.

Table 3. — Advantages of recommended near-term solar "A" sites in Lincoln, MA.

PUBLIC SAFETY BUILDING "A" rated	• Municipally owned and controlled • Large roof area with strong solar exposure • Solar generating capacity: 58.6 kW • Roof structurally sound well into the future • Visible location that reinforces the Lincoln's commitment to renewable green energy • MA DOER grant awarded for owner agent services to support this installation • Selectmen may be able to approve immediately • State-approved Solar developer Proposal for project
LANDFILL "A" rated	• Municipally owned and controlled • Large area with strong solar exposure • Estimated to support up to a 1+MW solar installation, approximately 50% of the electricity consumed by Town buildings • Landfills are commonly used for this purpose; many surrounding towns have installed PV systems on their landfills • State recently approved Solar as acceptable landfill use • State-approved Solar Developer Proposal for project

V. DISCUSSION OF "A" SITES

In our evaluation of the 25 sites in Lincoln there are seven sites that are rated "A". At this time the Town will be best-served by focusing on these priority properties. The "B" and "C" sites certainly warrant additional attention and should be seriously considered in the long-term. However, by moving ahead with the top sites is the quickest way to increase green energy capacity in our community.

The **Public School Campus** on Ballfield Road is a prime site for solar installation with four buildings and one parking lot "A" rated. The Schools are the largest municipal user of electricity, making this area a logical choice for green energy development. Also, we look to the built environment for increasing the Town's solar capacity at the lowest cost. Between the rooftops and parking area square footage, the Schools provide a significant amount of space for solar PV. Given the current planning efforts for updating or reconstructing the Schools, the timing is appropriate for incorporating solar into any redesign efforts. The Town needs to commit to making solar energy development a key element as the future of our Schools is determined by our residents.

Since the Schools is not a "near-term" viable option at this time, the Solar PV Working Group recommends proceeding immediately on the two "A" sites that are currently viable. This will move the Town in the proper direction for meeting the green energy goals outline earlier in this report.

The **Public Safety Building** is the project that is closest to being able to be constructed. The required approvals and planning efforts for this installation are minimal when compared to all the other sites. At this time this PV array should be moved along immediately. It is expected to have an output of 58.6 Kw. It has good solar orientation and the roof has a 40-year life span and the panels will be easy to mount on the metal roof. Public visibility at this site will help demonstrate to our residents and visitors that Lincoln is moving ahead with its commitment to being a Green Community. The Town has a state approved Solar developer who has submitted proposals for the project.

The **Landfill** Site is the "A" site with the largest solar capacity, potentially 1.376 MW, which would significantly offset municipal electricity demand and costs. Its large area of open field makes it a desirable site for a solar PV installation. Physical constraints do affect any installation at this site. Panel footings must be surface-mounted, with no ground penetration that would compromise the integrity of the cap. At the perimeter of the Landfill the surrounding tree canopy and wetland resource areas will limit panel location. Also, steep slopes may impact the installation. Overall, the site is 7.1 acres and the current plan is to use 5.8 acres for the solar array.

The site was originally used as the Town's landfill and was later capped with support from a State grant requiring that the land be permanently protected to preserve the integrity of the cap. Town Meeting complied with this requirement in 1995 by placing the Landfill into open space protected under MA Article 97, and put it under the care and custody of the Board of Selectmen. Recently the State has modified its policy for permitted uses of landfill sites to include municipal solar installations, where the town must adopt and amend its restriction for the new use. The Town has a state approved Solar developer who has submitted proposals for the project.

The State's Article 97 Land Disposition Policy of the Executive Office of Energy & Environmental Affairs (EOEEA – previously the EOEA), adopted in 1998, requires a number of steps to be taken for land to be removed from this protected status, including:

- Unanimous vote of the Conservation Commission that the land is surplus to municipal, conservation, and open space needs
- Two-thirds vote of Town Meeting in support of the disposition
- Two-thirds vote of the State Legislature in support of the disposition
- Real estate of equal or greater fair market value or value in use of proposed use, whichever is greater, and significantly greater resource value as determined by EOEEA is obtained in return

For a full Article 97 Disposition Policy narrative please refer to Appendix A. The Solar PV Working Group believes that pursuing solar at the Landfill will not in any way set a precedent for the disposition of conservation land holdings of the Town. The Solar PV Working Group agrees that the Landfill site may only be used if the Town fully complies with the requirements outlined above. The EOEEA staff person with primary responsibility for the Disposition Policy has confirmed the Town may proceed with solar at the Landfill. Lincoln Town Counsel has also provided guidance that the Town is properly addressing the Landfill solar project.

The Working Group recommends proceeding immediately with the steps outlined above. The Green Energy Committee secured a MA Department of Energy Resources grant to the Town for having an independent consulting company do a thorough site assessment and habitat evaluation for the Landfill. This helped

establish the ecological value of this land and the field study was conducted from the fall of 2015 to the summer of 2016 by Rimmer Environmental Consulting, LLC.[2]

Solar Working Group Projected Timeline

Date	Milestone	Comment
November 7, 2016	Selectmen voted to accept Working Group's Report	
November 12, 2016	Presentation to State of the Town Meeting	Informational Only
December, 2016	Conservation Commission's deliberations concerning petition to withdraw the Landfill parcel from Article 97 protection	Unanimous Commission vote required
December, 2016/January, 2017	Working Group completes due diligence including updating project financials	
January, 2017	Selectmen vote to hold a place on the Annual Town Meeting warrant for article(s) to authorize, as necessary, the Landfill and Public Safety Building installations	
February, 2017	Develop final warrant article and Annual Town Meeting article language	
March 25, 2017	Annual Town Meeting vote on whether to grant the necessary authorities to proceed with the projects.	2/3 vote of approval required
April, 2017	Submit Article 97 amendment petition to the Legislature	2/3 legislative vote of approval required
6 – 12 months later	Legislative approval	
6 – 12 months later	Approval by the Executive Office of Energy and Environmental Affairs	This is part of the legislative approval process
Early 2018	Negotiate agreements with solar development company	

VI. FINANCIAL INCENTIVES

[2] Rimmer Environmental Consulting, LLC. Town of Lincoln: Solar Site Assessment and Habitat Evaluation. June 7, 2016.

Federal and State government incentivizes the development of solar PV systems in various sectors by using grants, loans, and tax breaks. Lincoln's residents and government may be able to take advantage of some of the following programs to reduce costs and simplify the development of solar PV projects.

NET METERING

One financial incentive available in Massachusetts is net metering, a utility mechanism that tracks the net energy consumption by a home or facility with an installed solar PV system. Any excess solar generation that is not needed at the time of production will be fed into the grid, turning the meter backward to lower the meter reading. This results in net metering credits that will be shown on each month's electricity bill. When the PV system is not producing sufficient energy to cover the load of the facility, energy will be fed from the grid to supplement the power provided by the PV system. This will cause the meter to run forward and increase the meter reading.

The customer's electricity bill is equal to the total kilowatt-hours received from the utility grid in one month minus the total kilowatt-hours produced and fed into the grid that month. This net energy consumption number is then multiplied by the utility rates for electric power generation to determine the cost of the customer's electricity bill. The current net-metering policy gives equal value for 1 kWh provided to the grid by the customer and 1 kWh received from the grid. These credits from excess generation can roll over to the next month's electricity bills; this way if in one month more electricity is generated from the PV system than is consumed by the home or facility, the value of the excess energy generated can be applied to the following month's bill. Net metering credits roll over to the next electricity bill until the credits are used by the facility, so that the credits are never lost.

However, some solar PV systems are not immediately eligible for net metering, and are required to apply to an assurance program. To determine if a solar PV system automatically receives net metering, the system's alternating current (AC) size and the electrical service of the facility must be reviewed. Any PV system less than or equal to 10 kW_{AC} single-phase or 25 kW_{AC} three-phase is immediately eligible to net-meter; however systems larger than 10 kW_{AC} single-phase or 25 kW_{AC} three-phase must apply to receive a net metering allocation.[3] A typical home or small commercial facility has single-phase power, whereas a larger facility that requires a lot of power will generally have a three-phase service. Once a home or single phase power facility is larger than 10 kW or when a three-phase power facility is larger than 25 kW, both must apply and be granted an assurance before the installation can net meter.

There are many solar PV systems greater than 10 kW single-phase and 25 kW three-phase that would like to net meter; however, each utility has set a limit on how much solar PV can interconnect, based on the AC size of all the interconnected PV systems. This maximum AC capacity is equal to a percentage of each distribution company's highest historic peak load, which is the most energy demanded by its customers at one time.

Public sectors (i.e., government entities) and private sectors are in separate categories when applying to receive net metering allocation. The private net metering maximum capacity is set at 7% of each distribution company's highest peak load. The private National Grid cap was reached, and there is now a waiting list with customers who want to receive net metering if the cap is raised; all other distribution companies have space under their caps.

[3] Commonwealth of Massachusetts Executive Office of Energy and Environmental Affairs. Net metering FAQs. From http://www.mass.gov/eea/grants-and-tech-assistance/guidance-technical-assistance/agencies-and-divisions/dpu/net-metering-faqs.html, accessed July 6, 2016.

For the public sector, the net metering maximum capacity is 8% of each distribution company's highest peak load; as of October 2016, there is still space remaining under the cap for all public customers.[4]

Beginning on September 26, 2016, new "larger" solar installations will receive "market net metering credits." This means they will receive 60% of the net-excess generation in kilowatt-hours as net metering credits. The previous net metering system gave 100% of the net-excess generation in kilowatt-hours as net metering credits. This reduction in credits will change the financial viability of some solar PV projects. Systems that were previously installed have 25 years from the day that they were authorized to interconnect to receive full net metering values and then they transition to the new market net metering system with reduced values. Systems that are less than 10 kW single-phase or 25 kW three-phase, or that are of a municipality or government entity, are exempt from the new net metering rule.[5]

SOLAR CARVE-OUT (SREC-II) PROGRAM

Massachusetts implemented the Solar Carve-Out II program in 2014 with a goal of 1,600 MW_{AC} of solar capacity installed by 2020 within Massachusetts.[6] This program created the second Solar Renewable Energy Certificates (SREC-II) program. Facilities receive benefits, in addition to net metering, by participating in the Solar Carve-Out program: for example, one SREC is created each time a solar PV system generates 1MWh of energy. Each generated SREC is multiplied by an SREC factor of 1, 0.9, 0.8, or 0.7, depending on the generation unit type, as shown in Table 4.

Table 4. — SREC factors and corresponding generation units.[7]

Market sector	Generation unit type	SREC factor
A	1. Generation units with a capacity of <=25 kW_{DC} 2. Solar canopy generation units 3. Emergency power generation units 4. Community shared solar generation units 5. Low- or moderate-income housing generation units	1.0
B	1. Building-mounted generation units 2. Ground-mounted generation units with a capacity of > 25 kW_{DC} with 67% or more of the electric output on an annual basis used by an on-site load	0.9
C	1. Generation units sited on eligible landfills 2. Generation units sited on brownfields 3. Ground-mounted generation units with a capacity of <=650 kW with less than 67% of the electrical output on an annual basis used by an on-site load	0.8
Managed growth	Unit that does not meet the criteria of Market Sector A, B, or C	0.7

[4] To check up-to-date information on the remaining capacity available under each distribution company's public and private caps, visit: https://app.massaca.org/allocationreport/report.aspx.

[5] The 189th General Court of the Commonwealth of Massachusetts. General Laws: Part I, Title IX, Chapter 59, Section 5. From https://malegislature.gov/Laws/GeneralLaws/PartI/TitleIX/Chapter59/Section5, accessed July 6, 2016; The 189th General Court of the Commonwealth of Massachusetts. General Laws: Part II, Title I, Chapter 184, Section 23c. From https://malegislature.gov/Laws/GeneralLaws/PartII/TitleI/Chapter184/Section23c, accessed July 6, 2016; The 189th General Court of the Commonwealth of Massachusetts. H.Bill 4173. From https://malegislature.gov/Bills/189/House/H4173, accessed July 6, 2016.

[6] MW_{AC} refers to peak capacity power output after it's been converted to alternating current, or AC.

[7] Massachusetts Executive Office of Energy and Environmental Affairs. Solar Carve-Out II / SREC II. From http://www.mass.gov/eea/energy-utilities-clean-tech/renewable-energy/solar/rps-solar-carve-out-2/, accessed October 18, 2016.

For a parking lot that had a solar canopy installed, for example, the solar canopy generation units have an SREC factor of 1. When a solar canopy has produced 1 MWh of energy the owner is given 1 SREC. In contrast, a generation unit sited on a landfill has an SREC factor of 0.8. When this solar array produces 1MWh of energy, the owner will receive 0.8 SRECs.

All investor-owned utility (IOU) electricity providers are required to meet the Renewable Portfolio Standard (RPS) set by the State, which specifies that a utility needs to provide a set percentage of electricity from renewable sources, increasing at 1% per year until reaching 15% in 2020. This can be achieved by purchasing Renewable Energy Credits (RECs). The Solar Carve-Out program set aside a portion of the RPS for solar energy, meaning that utilities are obligated to purchase SRECs or produce a certain percentage of the electricity they provide from solar energy. If utilities fail to comply with the RPS, they must pay an Alternative Compliance Payment (ACP) for each megawatt hour they are short of meeting the RPS. Specifically, if a utility fails to purchase sufficient SRECs or produce enough of its own solar energy, it must pay the solar ACP (SACP). The SACP costs significantly more than SRECs, incentivizing utilities to meet the solar generation requirements of the RPS.[8]

THE END OF SREC-II

The state's goal of 1,600-MWac installed capacity has almost been reached in Massachusetts. As of July 18, 2016, there was 1,476.17 MW of qualified capacity for SREC-II; however, of that, only 508.53 MW of the qualified capacity was installed as of June 22.

By January 8, 2017, projects under 25 kW need to have a Statement of Qualification Application (SQA) and Permission to Operate (PTO) to be a part of the current SREC program. Projects that are more than 25 kW must have a PTO, be mechanically complete, or prove that they have spent 50% of project costs by January 8, 2017, to remain eligible under the current SREC-II program. They must also have a PTO and be mechanically completed by May 8, 2017.[9]

Systems that cannot meet these dates can still receive SREC-IIs, but the SREC factors will decrease according to the revised SREC Factor Guideline, which was published on August 31, 2016 and is detailed in Table 5.[10]

Table 5. — Revised Massachusetts SREC factors after August 31, 2016.

Market Sector	SREC Factor
A	0.8
B	0.7
C	0.65
Managed Growth	0.55

[8] More information about SREC-II can be found at http://www.srectrade.com/srec_markets/massachusetts.

[9] SREC Trade. Massachusetts SREC update, July 2016. From http://www.srectrade.com/blog/srec-markets/massachusetts/massachusetts-srec-update-july-2016, accessed July 19, 2016.

[10] Commonwealth of Massachusetts Department of Energy Resources. Renewable Energy Portfolio Standard (225 CMR 14.00) Guideline Revised August 31, 2016. From http://www.mass.gov/eea/energy-utilities-clean-tech/renewable-energy/solar/rps-solar-carve-out-2/minimum-standard-solar-carve-out-ii.html, accessed September 16, 2016.

Unfortunately, neither of the Working Group's recommended projects is currently on track to meet current deadlines. According to Sandra Brown of BlueWave Capital, LLC, at least 50% of project costs must be spent by January 8, 2016, which would need to be preceded by (a) determining an ownership structure, (b) filing and receiving an interconnection application (typically 60 days), and (c) ordering and delivering materials to the site and mobilizing a team for installation.[11]

FUTURE SOLAR INCENTIVE PROGRAM

Development is already underway for the next solar incentive program, which has the goal of being a cost-effective, long-term program.[12] Based on public comments, the new program may be "SREC-III," which would follow a similar format to the two previous programs with price adjustments. The next solar incentive may also address several disparities from the first two programs: the issue of low-income solar installations being ineligible for 40% of net metering credits; policies for renters of renewable energy generating facilities; community solar; green space protection; and other issues raised via public comments.[12] There is no specific date the new solar program is set to initiate.

Per BlueWave, it is important for Lincoln to move quickly on both projects to apply for the first round of funding under the upcoming Solar Incentive Program (SIP). This program effectively functions like a feed-in tariff, wherein for each kWh provided to the grid, the project would receive a fixed dollar amount for a specified term (typically 10–15 years).

VII. REGULATIONS AND INCENTIVES

SDA has analyzed the current solar policies within Lincoln to offer recommendations on how to remove impediments to accelerate the development of solar projects.

LINCOLN PHOTOVOLTAIC ZONING BYLAWS

In reviewing Lincoln's Land Use Permitting Guide (February 2016 edition), along with the Town's Zoning Bylaws (updated 2016), specific bylaws exist pertaining to both ground-mounted and roof-mounted solar PV systems. Zoning bylaw section 12.8, created in 2010, designates and defines the Solar Photovoltaic Facilities Overlay District and specifies the location on the Zoning Map (see Appendix B: Town of Lincoln Zoning Bylaws 12.8). Zoning Bylaw Section 13.6 specifies the stipulations for solar energy systems in Districts outside of the Solar Photovoltaic Facilities Overlay District.[13]

According to Section 12.8 of the Bylaws, it takes approximately 85 days for a PV system to receive all required permits and approvals to begin construction. Section 12.8.4 states the Planning Board needs to approve a site plan in accordance to Section 17 of the Zoning Bylaws before a building permit will be issued.

Section 17.2 outlines the necessary content of the site plan with Section 17.3 describing the procedure:

- Within 10 business days of the receipt of an application for site plan approval, the Planning Board or its agent shall determine whether or not the submission appears to provide all required information.

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[11] Brown, Sandra. Email to David O'Neil. October 12, 2016.

[12] Commonwealth of Massachusetts Executive Office of Energy and Environmental Affairs. Development of the Next Solar Incentive. From http://www.mass.gov/eea/energy-utilities-clean-tech/renewable-energy/rps-aps/development-of-the-next-solar-incentive.html, accessed July 19, 2016.

[13] The Town of Lincoln Building Department. *The Town of Lincoln Zoning By-law*. Lincoln, MA: The Town of Lincoln, 2010. 65-68. Print..

- After determining that the submission is complete or after the 10 days have past, the Planning Board will forward a notice of receipt of the site plan to the Board of Selectmen, the Board of Health, the Conservation Commission, the Board of Appeals, the Fire Department, Police Department, and Water Commission. Each group has 30 days to forward comments on the site plan.

- The Planning Board then has 45 days from site plan submission to hold a public hearing, and 30 days following this to make a decision.

Section 17.4 details the site plan approval standards and criteria, of which parts (f) Surface Water Drainage, (h) Utility Service, and (j) Special Features would likely be applicable to Lincoln's solar PV systems. Section 17.5 follows up with the necessary fees, although they are not specified. Section 12.8.5 calls for the interconnection documentation with the utility, which is common practice for these projects, as is the submittal for a plan of operation and maintenance in Section 12.8.7.

RECOMMENDATIONS TO ACCELERATE THE DEVELOPMENT OF GROUND-MOUNTED PV SYSTEMS

In reference to Section 12.8.4 and Section 17 which outline the approval process of site plans, one way to accelerate development would be to expedite the site plan approval process, which can be seen on a timeline in Table 6.[13]

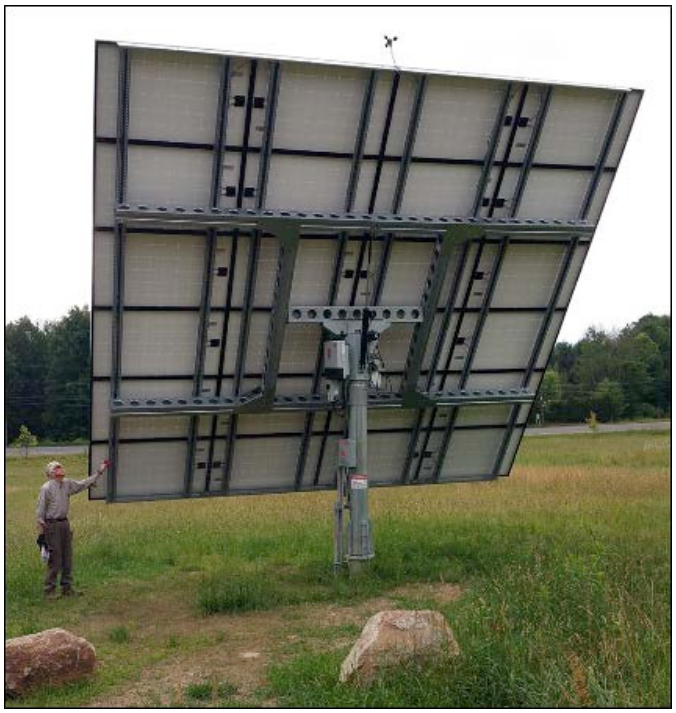
Table 6. — Lincoln, MA, timeline for approval of ground-mounted solar PV site plans.

Site Plan Approval Steps	Time [days post previous step]
Site plan submission	0
Determination of complete submission by Planning Board	10
Site plan comments by subsequent boards and departments	30
Public hearing on project held by Planning Board	15
Decision for permitting by Planning Board following public hearing	30
Total elapsed days	85

Recommendation No. 1 — As can be seen from Table 5, it could take up to 85 days to get a project approved by the Town of Lincoln. One obvious way to accelerate the development of such of a project would be to decrease the amount of days in the approval process through a change in the Town's zoning bylaws. Furthermore, when considering a ground-mounted PV array, it is stated that no site alteration or site development work including, but not limited to, removal of vegetation, soil excavation or grading shall occur prior to Planning Board approval as required under the zoning bylaws, a provision that delays the development of a PV project.

Recommendation No. 2 — A second remediation could be made to Section 12.8.6 of Lincoln's zoning bylaws, which states that the height of all structures comprising the SPF shall not exceed 20 feet above the pre-existing natural grade. While this may not limit ground-mounted structure height, it does eliminate possibilities for pole-mounted tracking systems that reach over 20 feet in height. This is disadvantageous, as pole-mounted systems may be able to produce more energy than fixed ground-mounted systems and may be more desirable in some locations. It is recommended that Section 12.8.6 be amended to reflect an increased height of 25 or 30 feet. An example of a pole-mounted PV system with a tracker can be seen in Figure 1.

Figure 1. — Example of a pole-mounted PV tracking system, Hampshire College, Amherst, MA.



Section 13.6 of the Zoning Bylaws sets guidelines for installations done within the Town. This section can be found in Appendix C: Town of Lincoln Zoning Bylaws 13.6.

Section 13.6 separates paths in 13.6.3(b) saying "whenever practical, all Solar Energy Systems shall be installed on an existing dwelling or building. All other systems shall require site plan review under Section 17.7." The two paths are a ground-mounted system on the property, or a roof-mounted system. The ground-mounted requires a site plan review, which would follow the same steps from Section 17 as reviewed earlier in this analysis. While it is not laid out in the bylaws, the roof-mounted system requires a building permit and electrical permit application with relevant information, including copies of contractor licenses and a worker's compensation affidavit.

Also, a fence is necessary for large ground-mounted arrays, which may require fence plan approval. This requires a permit from the Building Inspector when a fence exceeds 3.5 feet in height and is within 20 feet of a lot line bordering a public way or any publicly owned property. The fence plan approval process would occur within the entire Site Plan Review process.

Permitting is required with the Conservation Commission if:[14]

- The proposed area is within 100 feet of a wetland or 200 feet of a perennial stream or river;
- Proposed activities include building construction, vegetation removal, grading or excavating, or discharging stormwater;
- Activities that will remove, fill, dredge, or alter ponds, wetlands, or buffer zone resource areas are prohibited without first obtaining a permit from the Conservation Commission; and/or
- The Wetlands Protection Bylaw and associated regulations provide greater protection to resource areas than the Massachusetts Wetland Protection Act and Rivers Protection Act. Depending on the scope of a project, a Notice of Intent or Request for Determination of Applicability will have to be filed with site plans provided. A public hearing under both Town and State regulations will be concurrently held with the Conservation Commission approving or denying the project. A typical timeline for this process is just under two months and can take place in the same timeframe as the building permit process from the Planning Board.

Finally, the Town of Lincoln is a designated Green Community, a program of the Massachusetts Department of Energy Resources that helps cities and towns set energy reduction targets and offers technical and financial assistance. One step to becoming a Green Community was for Lincoln to pass Zoning Bylaw 12.8, which adopted "as-of-right siting" for solar, dedicating a specific plot of land for solar development and eliminating the need for special permits to be obtained to develop solar on that parcel.[15] Lincoln's "as-of-right siting" location is the Minuteman Regional High School Parking Lot.

Recommendation No. 3 — The Town of Lincoln could add sites upon which it intends to develop PV to Zoning Bylaw 12.8 that would not need special permits for solar development.

VIII. ECONOMICS

PRICE PER WATT

Generous Federal and State tax incentives and falling purchase and installation prices have helped make municipal solar PV power purchase agreement (PPA) installations very cost effective; however, the intent of these incentives is to make them revenue neutral compared to standard electricity purchased from investor-owned utility companies.

Municipal solar PV installations that are at least 50% complete by January 8, 2017 will qualify for incentives that will allow municipalities to purchase solar PV generated electricity below current investor-owned fossil fuel. The next set of state incentives is currently under review and has not been released yet. The Solar Working Group believes that Lincoln should assume that the incentives Massachusetts will release in the near future will be revenue neutral. The final price for electricity will be better defined as Lincoln's solar PV procurement process continues.

[14] The Town of Lincoln. "The Town of Lincoln Land Use Permitting Guide." 2016: 5-18.

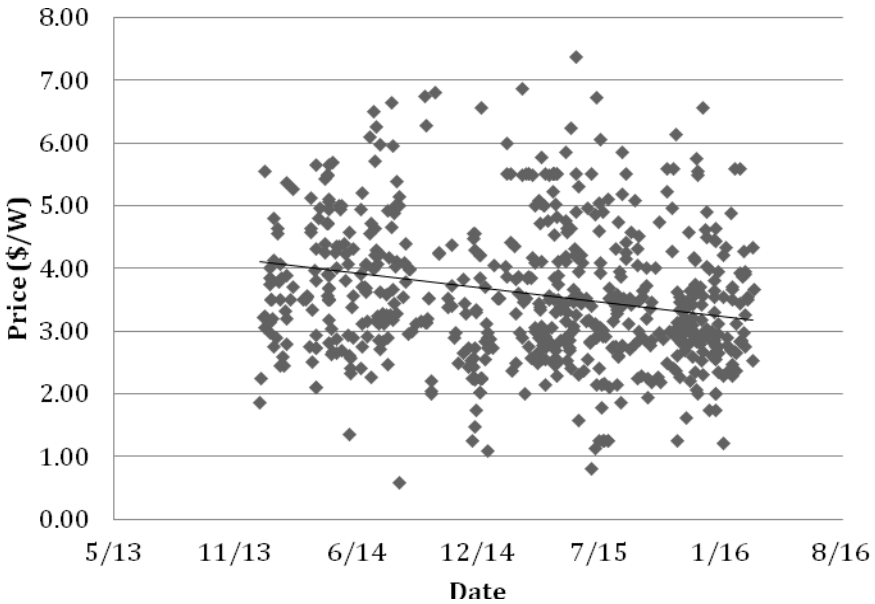
[15] Town of Lincoln Massachusetts. General and Zoning Bylaws. From http://www.lincolntown.org/index.aspx?NID=369, accessed July 6, 2016.

With the caveat that the current State solar PV installation incentives are in flux, SDA performed a market analysis to determine what Lincoln can expect to gain financially with respect to selling electricity back to the grid through solar electricity generation. To qualify for the SREC program, a systems cost (including design fees) must be reported; thus, the following Production Tracking System (PTS) data serves as an approximation of the price per watt costs of PV systems installed throughout Massachusetts.[16]

For this analysis, systems installed before January 1, 2014, were ignored. This is due to the trend of dropping module prices over the past few years, which skews the price of projects higher the further back in time one goes when compared to current systems costs. Additionally, solar PV systems without the following data points (or values of 0) were ignored: date in service, capacity (DC), and total cost with design fees.

This data set for commercial/municipal solar excluded any projects listed as residential under facility type. It also excluded any projects in the solarize program since nearly all projects in that program are residential. The overall scatter plot of per watt prices and in-service data can be seen in Figure 1.

Figure 2. — Price per watt of solar PV systems in Massachusetts: 2014–2016.



[16] All data is taken from SREC Production Tracking System (PTS) published by the MassCEC.

Average prices and the standard deviation for different years are shown in Table 7.

Table 7. — Average prices per watt and standard deviation of solar PV systems in Massachusetts: 2014–2016.

Year	Average Price ($/W)	Standard Deviation
2014	3.81	2.50
2015	3.53	1.15
2016	3.27	0.89

FINANCING OPTIONS

There are several common purchasing options in the solar industry that should be considered when procuring a solar system. The most common of these options include power purchase agreements (PPAs), solar leases, solar loans, or outright purchases.

The first two of these options, PPAs and solar leases, are third-party ownership models wherein the host customer does not own the solar system. Solar loans and outright purchases are ownership models in which the system is the property of the installing customer.[17]

PPAs are a financial arrangement where a developer designs and builds the solar system at the host customer's site, usually at no cost to the host. The host customer then purchases power produced by the solar system (which they do not own) at a rate that is typically lower than the utility's rate. An important caveat to PPAs is that the host customer is not eligible for any tax incentives, such as Modified Accelerated Cost Recovery System (MACRS) depreciation, which is generally only available for commercial entities, or ownership of the SRECs generated by the system.[18] One positive aspect to a PPA arrangement is that the developer is responsible for maintenance of the system, shielding the host customer from risk.

Solar leases are similar to an automobile lease agreement, wherein the host customer will sign up with a solar installer to lease a system installed on the host's property. The host customer makes payments on the system according to their contract with the lessor and in the end purchases the system from the lessor.[19] Responsibility for system maintenance or hardware issues associated with the system during the lease period varies based on the lease agreement.[20] The host customer will not typically be eligible for tax credits as they do not own the system. Transferal of SRECs may vary as defined by the lease agreement, so it is important to read the agreement carefully.

[17] Speer, Bethany. "Residential Solar Photovoltaics: Comparison of Financing Benefits, Innovations, and Options." National Renewable Energy Laboratory. 2012.

[18] Solar Energy Industries Association. Solar Power Purchase Agreements (PPAs). December 20, 2012. From http://www.seia.org/research-resources/solar-power-purchase-agreements, accessed August 10, 2016.

[19] Solar Energy Industries Association. Third-Party Financing. From http://www.seia.org/policy/finance-tax/third-party-financing, accessed August 10, 2016.

[20] Hausman, Nate, Emma Krause, and Kaitlin Kelly. "A Massachusetts homeowner's guide to solar leases, loans, and PPAs." Massachusetts Department of Energy Resources. December 2015. From http://www.mass.gov/eea/docs/doer/ma-homeowners-guide-to-solar-financing-final.pdf, accessed August 10, 2016.

Solar loan products are available to finance the cost of installing a PV system. Solar loans are available through participating banks and are used much like a mortgage; however, they are used to finance the PV system installed on a piece of property rather than the property itself. Loans are available from $3,000–$60,000 and typically come with a 10-year fixed rate.[21] The advantage of a solar loan is that it does not negatively impact tax incentive applicability as much as third-party ownership models, while it does not require significant capital on the part of the host.[22] Loan terms may vary, so it is crucial to determine SREC ownership specifics based on the loan documents.

Outright purchase of a solar system is the simplest of the four purchasing options. This option is best if a significant amount of capital is available. In most cases, outright purchase of a PV system proves to have the best net present value of the four options discussed and should be the first choice considered. Financial modeling can be done to determine if this is true based on project-specific variables, such as tax rates, SREC eligibility, net metering eligibility, etc.[23]

IX. ADDITIONAL RECOMMENDATIONS FOR GREENING LINCOLN

In addition to the adoption of energy efficiency measures outlined in Lincoln's Green Communities commitment, SDA recommends additional opportunities the Town can take advantage of to support renewable energy and energy efficiency.

MUNICIPAL FACILITIES

In addition to exploring municipally-owned solar, Lincoln has already taken steps towards reducing its carbon footprint. Lincoln can do (and in some cases, has done) the following as other towns have advantageously used grants though the DOER's Green Communities program, as shown in Table 8.

Table 8. — Additional energy-efficiency measures recommended for Lincoln.

Measure	Status
Improve energy of municipal buildings by replacing and upgrading HVAC equipment, replacing and upgrading windows, installing energy-efficient LED lighting, installing occupation lighting sensors, weatherizing buildings with increased and improved insulation, and installing an energy management system	Done
Change street lights to LED lighting	Done
Install electric vehicle (EV) charging stations at municipal buildings	Pending for Town Offices Building
Outfit buildings with Fault Detection Diagnostic (FDD) systems that can detect large sources of wasted energy in real time, allowing immediate adjustment to take place	Energy monitoring equipment is installed in several buildings

[21] Massachusetts Department of Energy Resources. Mass Solar Loan. From www.masssolarloan.com, accessed August 10, 2016.

[22] Massachusetts Department of Energy Resources. Mass Solar Loan: Frequently Asked Questions. From http://files.masscec.com/solar-loan/MassSolarLoanConsumerFAQ.pdf, accessed August 7, 2016.

[23] National Renewable Energy Laboratory. April 2010. From https://sam.nrel.gov, accessed August 7, 2016.

Install programmable thermostats in municipal buildings	Building management system (BMS) controls perform this task in most municipal buildings
Construct and invest in a community solar site	Pending
Outfit buildings with geothermal or air-sourced heating and cooling	Under review for the Public Library and an option for future School building renovations

X. ADDITIONAL READING

For further reference, please see:

- Town of Lincoln Building Permit Application
- Town of Lincoln Bylaws Article XVIII Wetlands Protection
- Town of Lincoln Land Use Permitting Guide
- Massachusetts Wetlands Protection Act 310 CMR 10.00
- Article 97: Constitution of the Commonwealth of Massachusetts
- Town of Lincoln Zoning Bylaw Sections 13.6 and 17.1-17.6
- Town of Lincoln, MA Landfill Solar Site Assessment and Habitat Evaluation, June 7, 2016

APPENDIX A: ARTICLE 97 POLICY

COMMONWEALTH OF MASSACHUSETTS
EXECUTIVE OFFICE OF ENVIRONMENTAL AFFAIRS

EOEA ARTICLE 97 LAND DISPOSITION POLICY
FEBRUARY 19, 1998

I. Statement of Policy

It is the policy of EOEA and its agencies to protect, preserve and enhance all open space areas covered by Article 97 of the Article of Amendment to the Constitution of the Commonwealth of Massachusetts. Accordingly, as a general rule, EOEA and its agencies shall not sell, transfer, lease, relinquish, release, alienate, or change the control or use of any right or interest of the Commonwealth in and to Article 97 land. The goal of this policy is to ensure no net loss of Article 97 lands under the ownership and control of the Commonwealth and its political subdivisions. Exceptions shall be governed by the conditions included in this policy. This policy supersedes all previous EOEA Article 97 land disposition policies.

An Article 97 land disposition is defined as a) any transfer or conveyance of ownership or other interests; b) any change in physical or legal control; and c) any change in use, in and to Article 97 land or interests in Article 97 land owned or held by the Commonwealth or its political subdivisions, whether by deed, easement, lease or any other instrument effectuating such transfer, conveyance or change. A revocable permit or license is not considered a disposition as long as no interest in real property is transferred to the permittee or licensee, and no change in control or use that is in conflict with the controlling agency's mission, as determined by the controlling agency, occurs thereby.

II. Conditions for Disposition Exceptions

EOEA and its agencies shall not support an Article 97 land disposition unless EOEA and its agencies determine that exceptional circumstances exist. A determination of 'exceptional circumstances" is subject to all of the following conditions being met:

1. all other options to avoid the Article 97 disposition have been explored and no feasible and substantially equivalent alternatives exist (monetary considerations notwithstanding).
   Note: The purpose of evaluating alternatives is to avoid using/affecting Article 97 land to the extent feasible. To that end, the scope of alternatives under consideration shall be commensurate with the type and size of the proposed disposition of Article 97 land, and must be performed by the proponent of the disposition to the satisfaction of EOEA and its agencies. The scope of alternatives extends to any sits that were available at the time the proponent of the Article 97 disposition first notified the controlling agency of the Article 97 land, and which can be reasonably obtained: (a) within the appropriate market area for private proponents, state and/or regional entities; or (b) within the appropriate city/town for municipal proponents.
2. the disposition of the subject parcel and its proposed use do not destroy or threaten a unique or significant resource (e.g., significant habitat, rare or unusual terrain, or areas of significant public recreation), as determined by EOEA and its agencies;
3. as part of the disposition, real estate of equal or greater fair market value or value in use of proposed use, whichever is greater, and significantly greater resource value as determined by EOEA and its agencies, are granted to the disposing agency or its designee, so that the mission and legal mandate of EOEA and its agencies and the constitutional rights of the citizens of Massachusetts are protected and enhanced;

4. the minimum acreage necessary for the proposed use is proposed for disposition and, to the maximum extent possible, the resources of the parcel proposed for disposition continue to be protected;
5. the disposition serves an Article 97 purpose or another public purpose without detracting from the mission, plans, policies and mandates of EOEA and its appropriate department or division; and
6. the disposition of a parcel is not contrary to the express wishes of the person(s) who donated or sold the parcel or interests therein to the Commonwealth.

III. Procedures for Disposition

Although legislation can be enacted to dispose of Article 97 land without the consent of an EOEA agency, it is the policy of EOEA to minimize such occurrences. To that end, and to ensure coordination, EOEA agencies shall:

1. develop an internal review process for any potential Article 97 land disposition to ensure that, at a minimum, the conditions in Section II above are met;
2. develop, through the Interagency Lands Committee, a joint listing of all requests, regardless of their status, for the disposition of Article 97 land;
3. notify the Interagency Lands Committee of any changes to the Article 97 land disposition list;
4. monitor all legislation that disposes of Article 97 land, and communicate with legislative sponsors regarding their intent;
5. recommend to the Secretary that the Governor veto any legislation that disposes of Article 97 land, the purchase, improvement, or maintenance of which involved state funds, on and for which the EOEA agency has not been consulted and received documentation (including information on title, survey, appraisal, and a MEPA review, all at the proponent's expense);
6. obtain the concurrence of the Secretary of EOA for any proposed Article 97 land disposition decision prior to finalizing said decision;
7. if recommending an Article 97 disposition, attach to all Article 97 legislative recommendations and TR-1 forms a justification of the disposition and an explanation of how it complies with this policy, signed by the EOEA agency head;
8. ensure that any conditions approved by EOEA and its agencies to any Article 97 land disposition are incorporated within the surplus declaration statement submitted to and published by DCPO as required by M.G.L. C. 7, §40F and 40F1/2 and throughout the disposition process, and if such conditions are not incorporated in said statement throughout the disposition process, the EOEA agency head shall recommend to the Secretary that the Governor veto any resulting legislation;
9. recommend to the Secretary that the Governor veto legislation that disposes of Article 97 land of which the agency disapproves; and
10. ensure that any Article 97 land disposition is authorized by enacted legislation and approved by all municipal, state and federal agencies, authorities, or other governmental bodies so required and empowered by law prior to conveyance.

IV. Applicability of the Policy to Municipalities

To comply with this policy, municipalities that seek to dispose of any Article 97 land must:

1. obtain a unanimous vote of the municipal Conservation Commission that the Article 97 land is surplus to municipal, conservation and open space needs;
2. obtain a unanimous vote of the municipal Park Commission if the land proposed for disposition is parkland;
3. obtain a two-thirds Town Meeting or City Council vote in support of the disposition;
4. obtain two-thirds vote of the legislature in support of the disposition, as required under the state constitution;

5. comply with all requirements of the Self-Help, Urban Self-Help, Land and Water Conservation Fund, and any other applicable funding sources; and
6. comply with EOEA Article 97 Land Disposition Policy [note: the municipality must also file an Environmental Notification Form with EOEA's MEPA office].

After the effective date of this policy, any municipality that proposes, advocates, supports or completes a disposition of Article 97 land without also following the terms of this policy, regardless of whether or not state funds were used in the acquisition of the Article 97 land, shall not be eligible for grants offered by EOEA or its agencies until the municipality has complied with this policy. Compliance with this policy by municipalities shall be determined by the EOEA Secretary, based on recommendations by the EOEA Interagency Lands Committee.

Trudy Coxe, Secretary
Executive Office of Environmental Affairs

APPENDIX B: TOWN OF LINCOLN ZONING BYLAWS 12.8

12.8 SP - SOLAR PHOTOVOLTAIC FACILITIES OVERLAY DISTRICT

12.8.1 The purpose of this Section 12.8 is to promote the creation of new large-scale ground-mounted solar photovoltaic facilities (SPFs) by: establishing areas for construction of SPFs; providing standards for the placement, design, construction, operation, monitoring, modification and removal of such facilities, which standards address public safety and minimize impacts on scenic, natural and historic resources; and providing adequate financial assurance for the eventual decommissioning of such facilities.

12.8.2 This section 12.8 applies to and permits the installation and operation of large- scale (nameplate capacity of 250 kW DC or greater) ground-mounted SPFs in accordance with the provisions hereunder. This section also pertains to physical modifications that materially alter the type, configuration, or size of these facilities or related equipment.

12.8.3 LOCATION: The Solar Photovoltaic Facilities Overlay District shall consist of the following areas:

1) An area of approximately 5.7 acres within Assessor's Map 19, Parcel 4-0, off North Great Road, bounded as follows: from the intersection of the northern lot boundary with the Lexington town line, running roughly south along the Lexington town line for 350 feet, then due west for 700 feet, then due north to the northern lot boundary and then roughly east along the various segments of the northern lot boundary to the Lexington town line.

12.8.4 No building permit shall be issued for an SPF without prior approval by the Planning Board of a site plan in accordance with the provisions of Section 17 of this bylaw. Site plans shall be deemed constructively approved if not acted upon within one year after submission of complete plans.

12.8.5 Applications for Site Plan Review shall include evidence that the utility company that operates the electrical grid where the facility is to be located has been informed and consents to the solar photovoltaic facility owner or operator's plan to connect to the electrical grid. Off-grid systems are exempt from this requirement.

12.8.6 The height of all structures comprising the SPF shall not exceed 20 feet above the pre-existing natural grade.

12.8.7 The applicant shall submit a plan for the operation and maintenance of the SPF.

12.8.8 The owner, operator, successors, and assigns of the SPF shall maintain the facility in good condition. Maintenance shall include, but not be limited to, painting, structural repairs, and integrity of security measures.

12.8.9 All structures associated with an SPF shall be removed within one year of cessation of use. The owner or operator shall notify the Planning Board by certified mail of the proposed date of discontinued operations and plans for removal. Removal shall include:

a) Removal of all structures, equipment, security barriers and transmission lines from the site.
b) Disposal of all solid and hazardous waste in accordance with local, state, and federal waste disposal regulations.
c) After consultation with the Planning Board, stabilization or re-vegetation of the site as necessary to minimize erosion. The Planning Board may allow the owner or operator to leave landscaping or designated below-grade foundations in order to minimize erosion and disruption to vegetation.

12.8.10 Applicants, other than governmental authorities, shall provide a form of surety, either through escrow account, bond or otherwise, to cover the cost of removal in the event the Town must remove the SPF and remediate the landscape, in an amount and form determined to be reasonable by the Planning Board, but in no event to exceed 125 percent of the cost of removal and compliance with the additional requirements set forth herein, as determined by the project proponent. The project proponent shall submit a fully inclusive estimate of the costs associated with removal, prepared by a qualified engineer. The amount shall include a mechanism for calculating increased removal costs due to inflation.

APPENDIX C: TOWN OF LINCOLN ZONING BYLAWS 13.6

13.6 Solar Energy Systems.

13.6.1 Purpose: The purpose of this Solar Energy System By-Law is to encourage investment in Solar Energy Systems in the Town of Lincoln, while providing guidelines for the installation of those systems that are consistent with the character of the Town and are necessary to protect the public health, safety and general welfare.

13.6.2 Definitions: Building-Integrated Solar Energy System - A Solar Energy System that is an integral part of a principal or accessory building replacing or substituting for an architectural or structural component of the building. Building-Integrated Solar Energy Systems include but are not limited to Photovoltaic, hot air, or hot water solar systems that are contained within roofing materials, walls, windows, or skylights.

Photovoltaic (PV) — The technology that uses a semi-conductor material to convert light directly into electricity.

Solar Collector Panel — Any part of a Solar Energy System that absorbs solar energy for use in the system's energy transformation process. The Solar Collector Panel does not include frames, supports, or mounting hardware.

Solar Energy System — A device or structural design feature, a substantial purpose of which is to provide for the collection, storage, and distribution of solar energy for space heating or cooling, electrical generation, or water heating.

13.6.3 General Standards

(a) A Solar Energy System shall provide power for the principal use and /or accessory use of the property on which the Solar Energy System is located and shall not be used for the generation of power for the sale of energy to other users, although this provision shall not prohibit the sale of excess power generated to the local utility company.
(b) Whenever practical, all Solar Energy Systems shall be installed on an existing dwelling or building. All other systems shall require site plan review under Section 17.7.
(c) A Solar Energy System shall not be used to display advertising, including but not limited to signage.
(d) Solar Energy Systems shall be placed and arranged such that reflected solar glare shall not be directed onto adjacent buildings, properties or roadways.
(e) Roof-mounted Solar Energy Systems shall be set back a minimum of 1 foot from all roof edges (eaves, gutterline, ridge) of the roof surface.
(f) Appurtenant electric, piping, wiring or equipment for Solar Energy Systems shall be allowed to extend beyond the perimeter of the building on a side or rear yard exposure.

13.6.4 Design Standards in Residential Districts

(a) Building-Mounted Solar Energy Systems: Building-mounted Solar Energy Systems are permitted in the following locations:
    i. On the roofs of principal and accessory structures, and/or
    ii. On side and rear building facades
    iii. Building-Integrated Solar Energy Systems are also permitted on front or corner building facades

All Solar Energy System appurtenances such as, but not limited to, plumbing, water tanks, mounting structures, and support equipment shall be screened to the maximum extent possible without compromising the effectiveness of the Solar Collector Panels.

(b) Roof-Mounted Solar Energy Systems: All roof-mounted Solar Collector Panels on a sloped roof will be subject to the following height limitations:
    i. The top surface of any Solar Collector Panel mounted on a south-facing sloped roof shall not exceed 12 inches above the adjacent finished roof surface
    ii. The top surface of any Solar Collector Panel mounted on a north-, east-, or west-facing sloped roof shall not exceed 24 inches above the adjacent finished roof surface

iii. The top most point of any Solar Collector Panel mounted on a flat roof (1/2 inch or less per foot slope) shall not exceed 30 inches above the adjacent finished roof surface on flat roofs with or without parapets

The Planning Board may waive strict compliance of these height limitations and allow a roof-mounted solar energy system to exceed such height limitations where it determines such action to be consistent with the purpose and intent of the zoning bylaw and otherwise in the public interest.

(c) Ground-Mounted Solar Energy Systems: Ground mounted Solar Energy Systems shall be treated as an accessory structure and require site plan review under Section 17.7.

Ground-mounted Solar Energy Systems shall comply with all minimum setback requirements. Ground-mounted Solar Energy Systems shall not be located within the front yard, defined as the area between the front façade of the dwelling extended to the side property lines and extending to the street line (corner lots have two (2) front facades).

Ground- or pole-mounted Solar Energy Systems shall not exceed the maximum height of ten feet. The Planning Board may waive strict compliance and allow a ground- or pole- mounted Solar Energy System to exceed such height limitation where it determines such action to be consistent with the purpose and intent of the zoning bylaw and otherwise in the public interest.

13.6.5 Design Standards in Non-Residential Districts

(a) Building-Mounted Solar Energy Systems

Building-mounted Solar Energy Systems are permitted in the following locations:

i. On the roofs of principal and accessory structures, and/or
ii. On side and rear building facades
iii. In addition, Building-Integrated Solar Energy Systems are permitted on front or corner building facades

All Solar Energy System appurtenances such as, but not limited to, plumbing, water tanks, mounting structures, and support equipment shall be screened to the maximum extent possible without compromising the effectiveness of the Solar Collector Panels.

(b) Roof-Mounted Solar Energy Systems: All roof-mounted Solar Collector Panels on a sloped roof will be subject to the following height limitations:

i. The top surface of any Solar Collector Panel mounted on a south-facing sloped roof shall not exceed 12 inches above the adjacent finished roof surface
ii. The top surface of any Solar Collector Panel mounted on a north-, east-, or west-facing sloped roof shall not exceed 24 inches above the adjacent finished roof surface
iii. The top most point of any Solar Collector Panel mounted on a flat roof (1/2 inch or less per foot slope) shall not exceed 30 inches above the adjacent finished roof surface on flat roofs with or without parapets

The Planning Board may waive strict compliance of these height limitations and allow roof-mounted Solar Energy Systems to exceed such height limitations where it determines such action to be consistent with the purpose and intent of the zoning bylaw and otherwise in the public interest.

(c) Ground-Mounted Solar Energy Systems

Ground-mounted Solar Energy Systems shall be treated as an accessory structure and require site plan review under Sections 17.1-17.6.

Ground-mounted Solar Energy Systems shall comply with all minimum setback requirements. Ground-mounted Solar Energy Systems shall not be located within the front yard, defined as the area between the front façade of the main building (or structure) extended to the side property lines and extending to the street line (corner lots have two (2) front facades).

A ground- or pole-mounted Solar Energy System shall not exceed the maximum height of ten feet. The Planning Board may waive strict compliance of this height limitation and exceed such height limitation where it determines such action to be consistent with the purpose and intent of the zoning bylaw and otherwise in the public interest.

13.7 Site Plan Review: Specifically described uses that generate 50 or more trips per day according to the ITE Trip Generation Manual shall, upon application for a building permit, be subject to Site Plan Review by the Planning Board in accordance with Section

17.7 in the R1 district and Sections 17.1-17.6 in all other districts.

APPENDIX D: SITE ANALYSIS OF CODMAN C. FARMS PASTURE

Size: ~132,000 sq ft
Capacity: 496.3 kW_{DC}
Orientation: South (180°)
Overall grade: C

Reasoning for grade:
Very large pasture area, absence of shading obstructions; however, a large-scale, dense installation would have severe adverse agricultural impacts. A smaller demonstration installation might be possible.

Topography, stability, and access:
Site is relatively flat, areas that are not flat could be leveled during construction, ground solid and rocky, access road is developed with existing dirt/asphalt roads.

Cultural and historic importance:
The structures shown below are designed to allow livestock to pass underneath the array or certain crops to be grown. However, this area is a key scenic and historic center of a community that cherishes its agricultural heritage and the limits a solar array would impose on a newly revitalized farming operation will not be acceptable to the Lincoln community at this time.

Current usage:
Community farming center.

Impacts on wildlife and surrounding habitat:
Wetlands are located directly adjacent to the South side of this site.

Concerns of neighbors, abutters, and others:
Visibility concerns on this publicly owned land are dependent on how a PV array is viewed by visitors. A PV array in a pasture may be viewed as a symbol of sustainable living concurrent with locally sourced agriculture. Codman Community Farms is used as a teaching facility and having such an innovative solar design could inspire and educate community members. That said, this parcel is considered part of a historic area and historic road. The presence of a PV array will not be seen favorably because it takes away from the historic value.

Permitting, zoning, and regulatory considerations:
This pasture may be within the 100' buffer zone resource area, and as such permitting may pose an issue for this ground-mounted array. In Historic District.

Solar array technology:
A smaller demonstration project would use the dual-use ground mount racking available from Hyperion Systems for this array field. This system would allow livestock to pass underneath or plants to grow without damaging the modules or the racking.

APPENDIX E: SITE ANALYSIS OF CODMAN COMMUNITY FARMS MAIN BUILDING

Size: ~4,400 sq ft
Capacity: 48.4 kW_{DC}
Orientation: East (79°), West (259°), South (169°)
Overall grade: C

Reasoning for grade:
Most modules are not on a south-facing roof; in Historic District

Topography, stability, and access:
Roof is flat and area is developed with existing dirt/asphalt roads.

Cultural and historic importance:
This building is a part of the Historic District and is a historic building, therefore siting solar panels on it may be disruptive to the cultural significance of this building.

Current usage:
Community farming center and assembly area

Impacts on wildlife and surrounding habitat:
Wetlands are located approximately 220' from this building, which is out of the wetlands buffer zone.

Concerns of neighbors, abutters, and others:
The site is in a rural area but in close proximity to an automobile service station. Visibility concerns on this publicly-owned building are dependent on how the PV array is viewed by visitors A PV array on a farm facility may be viewed as a symbol of sustainable living concurrent with locally sourced agriculture. This parcel is considered part of a historic area and historic road. The presence of a PV array may not be seen favorably because it takes away from the historic value.

Permitting, zoning, and regulatory considerations:
This building will likely require additional permits as it considered a historic building.

Solar array technology:
It is recommended to use conventional high capacity modules on this roof. Due to high labor costs, it is advisable to use higher wattage modules on small roof mount arrays such as this one.

APPENDIX F: SITE ANALYSIS OF CODMAN COMMUNITY FARMS OUTBUILDING 1

Size: ~750 sq ft sq ft
Capacity: 7.8 kW_{DC}
Orientation: East (78°), West (258°)
Overall grade: C

Reasoning for grade:
Small roof area impedes financial viability due to fixed costs of installing an array, modules are not on a south-facing roof, potentially unstable roof, shading issues from other building, historic area

Topography, stability, and access:
Roof is flat, roof may need replacement, and area is developed with existing dirt/asphalt roads.

Cultural and historic importance:
This building is a part of the historic district and is a historic building, therefore siting solar panels on it may be disruptive to the cultural significance of this building, which is very old.

Current usage:
Community farming center and assembly area

Impacts on wildlife and surrounding habitat:
Wetlands are located approximately 180 feet from this building.

Concerns of neighbors, abutters, and others:
Visibility concerns on this publicly-owned building are dependent on how the PV array is viewed by visitors. This parcel is considered part of a historic area and historic road. The presence of a PV array may not be seen favorably because it takes away from the historic value.

Permitting, zoning, and regulatory considerations:
Historic District.

Solar array technology:
It is recommended to use conventional high capacity modules on this roof. Due to high labor costs, it is advised to use higher wattage modules on small roof mount arrays such as this one.

APPENDIX G: SITE ANALYSIS OF CODMAN COMMUNITY FARMS OUTBUILDING 2

Size: ~925 sq ft
Capacity: 10.7 kW_{DC}
Orientation: East (80°), West (260°)
Overall grade: C

Reasoning for grade:
Small roof area impedes financial viability due to fixed costs of installing an array, modules are not on a south-facing roof, potentially unstable roof depending on age of barn, located in Historic District.

Topography, stability, and access:
Roof is flat, roof may need replacement, and area is developed with existing dirt/asphalt roads.

Cultural and historic importance:
This building is a part of the Historic District and is a historic building, therefore siting solar panels on it may be disruptive to the cultural significance of this building.

Current usage:
Community farming center and assembly area

Impacts on wildlife and surrounding habitat:
None – roof array.

Concerns of neighbors, abutters, and others:
Visibility concerns on this publicly owned building are dependent on how as a symbol of sustainable living concurrent with locally sourced agriculture.

Permitting, zoning, and regulatory considerations:
Historic District.

Solar array technology:
It is recommended to use conventional high capacity modules on this roof. Due to high labor costs, it is advised to use higher wattage modules on small roof mount arrays such as this one.

APPENDIX H: SITE ANALYSIS OF CODMAN COMMUNITY FARMS OUTBUILDING 3

Size: ~925 sq ft
Capacity: 22.1 kW_{DC}
Orientation: East (80°), West (260°)
Overall grade: C

Reasoning for grade:
Moderately sized roof area, modules are not on a south-facing roof, potentially unstable roof depending on age of barn, shading from tree next to building, which will continue to grow and shade the array with time, located in historic area

Topography, stability, and access:
Roof is flat, roof condition is uncertain, and area is developed with existing dirt/asphalt roads.

Cultural and historic importance:
This building is a part of the Historic District and is a historic building, therefore siting solar panels on it may be disruptive to the cultural significance of this building.

Current usage:
Community farming center and assembly area

Impacts on wildlife and surrounding habitat:
None – roof array.

Concerns of neighbors, abutters, and others:
Visibility concerns on this publicly owned building are dependent on how the PV array is viewed by visitors. A PV array on the roof of a community farm building may be viewed as a symbol of sustainable living concurrent with locally sourced agriculture.

Permitting, zoning, and regulatory considerations:
Historic District

Solar array technology:
It is recommended to use conventional high capacity modules on this roof. Due to high labor costs, it is advisable to use higher wattage modules on small roof mount arrays such as this one.

APPENDIX I: SITE ANALYSIS OF DECORDOVA PARKING CANOPY

Size: ~30,600 sq ft
Capacity: 432 kW_{DC}
Orientation: East (103°), West (283°)
Overall grade: C

Reasoning for grade:
Large parking lot size, location within wetland buffer zone, high cost typical of parking canopies, shading from trees next to canopy, which will continue to grow and shade the array with time. The parking canopy design needs to be high enough to allow for large 18-wheeler trucks which would increase the cost of procurement and installation of a PV system. Additionally, this lot is privately managed and the Town has limited control over the land.

Topography, stability, and access:
Area is developed as an asphalt parking lot, West side is flat, East parking row is split vertically on the North side by a 2ft slope and on the South side by a 4.5' slope (better seen in pictures)

Cultural and historic importance:
This sculpture park and museum could benefit from the installation of a PV parking canopy, if installed in an aesthetically pleasing manner.

Current usage:
Parking lot for a sculpture park and museum. Also serves as an area for sculptures to be delivered and staged so large trucks need to be able to continue to utilize the parking area

Impacts on wildlife and surrounding habitat:
Much of the proposed canopy is within the 100' wetlands buffer zone resource area. Wetlands are located directly adjacent to the parking lot. This may pose a permitting issue.

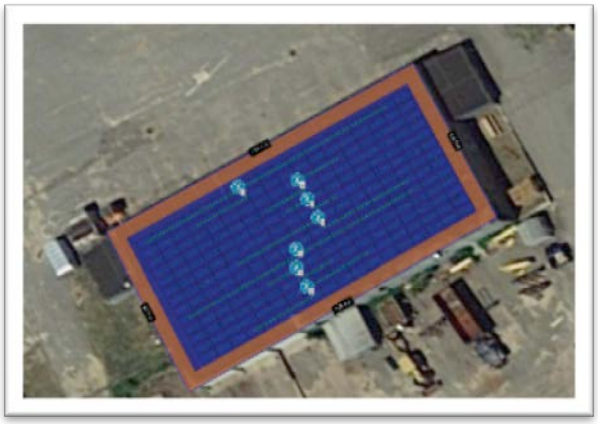
Concerns of neighbors, abutters, and others:
The site is in a rural area shrouded by trees. Visibility concerns are dependent on how the PV array is viewed by visitors to the museum. Visitors to this establishment may have a tendency to be more sensitive to negative aesthetic impacts from a large canopy structure, or if the canopy is viewed as a sculpture then it has a possibility of being viewed positively.

Permitting, zoning, and regulatory considerations:
Much of the proposed canopy is within the 100' wetlands buffer zone. Wetlands are located directly adjacent to the parking lot. This may pose a permitting issue.

Solar array technology:
It is recommended to use conventional high capacity modules on this parking canopy. Due to high structural costs associated with parking canopies, it generally makes sense to use high capacity modules to maximize the power output for a given canopy size.

APPENDIX J: SITE ANALYSIS OF DEPARTMENT OF PUBLIC WORKS BUILDING

Size: ~8,515 sq ft
Capacity: 74.9 kW_{DC}
Orientation: South (151°)
Overall grade: B



Reasoning for grade:
South facing array, no trees to shade array, and no wetlands concerns. The roof condition may be an issue. There are discussions on whether this building will remain the public safety building or renovated for another use. If a PV system would be removed soon after installation, it does not make financial sense to complete this project.

Topography, stability, and access:
Roof is flat, roof needs to be inspected by a structural engineer to determine if it can hold a ballasted solar array, the building was erected in 1948 and the roof was updated in 2004. When the roof was redone a lighter membrane was implemented than the membrane the roof was designed to support, the building is 16' tall, area is developed as a garage for municipal vehicles.

Cultural and historic importance:
There is no cultural or historic importance of the DPW building.

Current usage:
Garage for Highway Department vehicles.

Impacts on wildlife and surrounding habitat:
The array is in a relatively industrial area of Town, so wildlife and natural habitat concerns are likely to be non-issues.

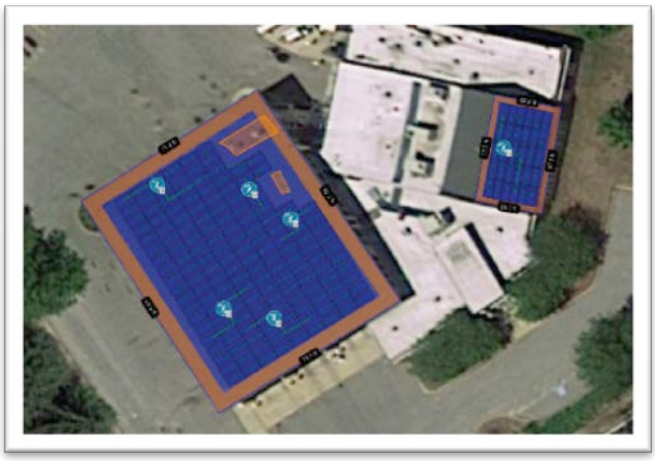
Concerns of neighbors, abutters, and others:
Residential neighbors to this site are unlikely to be concerned with a PV array being installed on the roof of the garage, as they already live next to an area where trucks enter and exit on a daily basis.

Permitting, zoning, and regulatory considerations:
As this is a Town-owned industrial building, there will likely be few permitting/zoning issues.

Solar array technology:
It is recommended to use conventional high capacity modules on this roof. Due to high labor costs, it is advised to use higher wattage modules on small roof mount arrays such as this one.

APPENDIX K: SITE ANALYSIS OF PUBLIC SAFETY BUILDING

Size: ~7,115 sq ft
Capacity: 58.6 kW_{DC}
Orientation: South (148°), East (101°)
Overall grade: A



Reasoning for grade:
Large main roof will have a South facing array, few trees to shade array. Roof structurally solid. Town-owned property. Visible location to highlight local green energy. MA DOER grant awarded to support installation. State-approved Solar developer Proposal for development. These are all positive factors making this a key priority for a rapid response on installation.

Topography, stability and access:
Main roof has slight curvature, small roof is flat, both roofs replaced in 1998 and have a 40-year life-span. Roof is a standing seam construction that provides the simplest PV installation because the method to fix the PV array to the roof does not penetrate the roof. Area is well-developed.

Cultural and historic importance:
The small roof is facing Lincoln Road in an area that may be of historic interest.

Current usage:
Police and Fire Department Headquarters

Impacts on wildlife and surrounding habitat:
The array is outside of any wetland buffer zones. Roof mounted arrays do not pose a significant hazard to wildlife.

Concerns of neighbors, abutters, and others:
The large roof on this building is substantially elevated since it accommodates fire apparatus parking. This means the primary array would not be highly visible but it limits tree shading. The small roof faces Lincoln Road at the busy intersection with Codman Road, so an array facing this area would show the Town's commitment to sustainable green energy production and its reduced carbon footprint and associated climate change benefits.

Permitting, zoning, and regulatory considerations:
Minimal permitting issues.

Solar array technology:
It is recommended to use conventional high capacity modules on this roof. Due to high labor costs, it generally makes sense to use higher wattage modules on small roof mount arrays such as this one.

APPENDIX L: SITE ANALYSIS OF RURAL LAND FOUNDATION (LINCOLN STATION) PARKING CANOPY

Size: ~14,692 sq ft
Capacity: 188 kW_{DC}
Orientation: (South 140°)
Overall grade: B

Reasoning for grade:
Large parking lot size, high cost typical of parking canopies, very little shading from trees near canopy. This parking lot is not Town-owned so municipal officials must work with the owner to discuss the benefits of a parking canopy. Due to the infrastructure of a canopy, the parking lot may lose a few parking spaces.

Topography, stability, and access:
Site is flat and area is developed as an asphalt parking lot.

Cultural and historic importance:
Area is a parking lot in a shopping center and there are no known cultural/historic concerns.

Current usage:
Parking lot for a shopping center.

Impacts on wildlife and surrounding habitat:
A small portion of the array may be within the wetlands buffer zone but the installation would be on existing impervious asphalt.

Concerns of neighbors, abutters, and others:
The parking lot is shared between private businesses. It is important to confirm that whomever they contract for snow plowing will be able to use equipment compatible with the canopy to avoid structural damage.

Permitting, zoning, and regulatory considerations:
A small portion of the array may be within the wetlands buffer zone resource area. The wetlands of concern are across the tracks near Codman Farm. This may pose a permitting issue.

Solar array technology:
It is recommended to use conventional high capacity modules on this parking canopy. Due to high structural costs associated with parking canopies, it generally makes sense to use high capacity modules to maximize the power output for a given canopy size.

APPENDIX M: SITE ANALYSIS OF TOWN COMMUTER LOT

Size: ~31,824 sq ft
Capacity: 206 kW_{DC}
Orientation: (East 61°), (West 241°)
Overall grade: C

Reasoning for grade:
Large parking lot size, south-facing canopies could not be easily built, location within wetland buffer zone resource area, high cost typical of parking canopies, need to cut down trees directly adjacent to canopy or have significant shading from nearby trees, shading from trees located further from canopy, which will continue to grow and shade the array over time.

Topography, stability, and access:
Site is flat, area is developed as an asphalt parking lot.

Cultural and historic importance:
Area is in a parking lot near a shopping center and there are no known cultural/historic concerns.

Current usage:
Parking area for MBTA commuters

Impacts on wildlife and surrounding habitat:
Minimal – area already paved.

Concerns of neighbors, abutters, and others:
The site is in an area surrounded by trees so there are no visibility concerns. Additionally, people who use the MBTA services may be using them because of the positive environmental aspects of public transportation so they may welcome another green-innovation.

Permitting, zoning, and regulatory considerations:
Much of the proposed canopy is within the wetlands buffer zone resource area. The wetlands of concern are across the tracks near Codman Farm. This may pose a permitting issue.

Solar array technology:
It is recommended to use conventional high capacity modules on this parking canopy. Due to high structural costs associated with parking canopies, it generally makes sense to use high capacity modules to maximize the power output for a given canopy size.

APPENDIX N: SITE ANALYSIS OF WATER TREATMENT PLANT

Size: ~4,032 sq ft
Capacity: 23.7 kW_{DC}
Orientation: South (148°), East (101°)
Overall grade: C

Reasoning for grade:
Array does not face south, shading from trees nearby, which will continue to grow and shade the array over time, obstructions on roof.

Topography, stability, and access:
Site flat, roof has multiple obstructions, and area is well developed.

Cultural and historic importance:
There is no immediately apparent cultural or historic importance of the Water Treatment Plant.

Current usage:
Water Treatment Plant

Impacts on wildlife and surrounding habitat:
Trees would need to be cut or trimmed.

Concerns of neighbors, abutters, and others:
The building is in a very rural area of Town with trees between all neighbors.

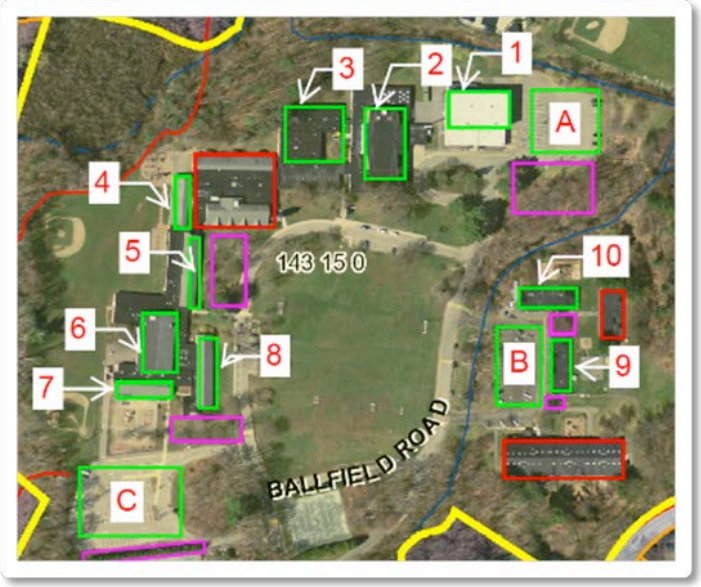
Permitting, zoning, and regulatory considerations:
None

Solar array technology:
It is recommended to use conventional high-capacity modules on this roof. Due to high labor costs, it generally makes sense to use higher wattage modules on small roof mount arrays such as this one.

APPENDIX O: SITE ANALYSIS OF SCHOOL PARKING LOT A

Size: ~14,237 sq ft
Capacity: 188 kW_{DC}
Orientation: (East 90°), (West 270°)
Overall grade: B/C

Reasoning for grade:
Large parking lot size, canopies would not be easily built facing south, location within wetland buffer zone, high cost typical of parking canopies, need to cut down trees directly adjacent to canopy, shading from trees located further from canopy, which will continue to grow and shade the array with time. The high roof on the West building will shade the West arrays, so it should be discussed if the West canopy is worth development.



Layout of Lincoln public schools

Topography, stability, and access:
Site is flat; area is developed as an asphalt parking lot.

Cultural and historic importance:
Area is a parking lot adjacent to a public school.

Current usage:
Parking area for public school

Impacts on wildlife and surrounding habitat:
Minimal – area is already paved.

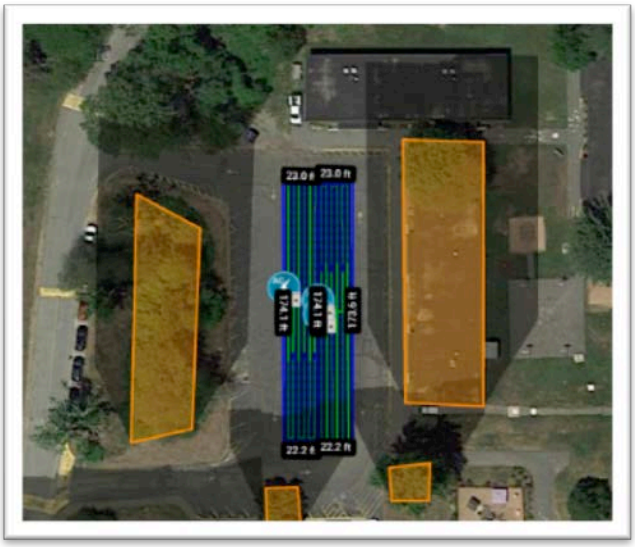
Concerns of neighbors, abutters, and others:
The site is in an area shrouded entirely by trees, so there should be no visibility concerns to neighbors.

Permitting, zoning, and regulatory considerations:
Part of the proposed canopy will likely require wetlands permitting.

Solar array technology:
It is recommended to use conventional high capacity modules on this parking canopy. Due to high structural costs associated with parking canopies, it generally makes sense to use high capacity modules to maximize the power output for a given canopy size.

APPENDIX P: SITE ANALYSIS OF SCHOOL PARKING LOT B

Size: ~10,120 sq ft
Capacity: 102.6 kW_{DC}
Orientation: (East 90°), (West 270°)
Overall grade: B



Reasoning for grade:
Large parking lot size, canopies could not be easily built facing south, location within wetland buffer zone, high cost typical of parking canopies

Topography, stability, and access:
Site is flat; area is developed as an asphalt parking lot.

Cultural and historic importance:
Area is a parking lot adjacent to a public school.

Current usage:
Parking area for public school compound

Impacts on wildlife and surrounding habitat:
Minimal – area is paved already.

Concerns of neighbors, abutters, and others:
The site is in an area shrouded entirely by trees so there are no visibility concerns to neighbors.

Permitting, zoning, and regulatory considerations:
Wetlands permitting may be required.

Solar array technology:
It is recommended to use conventional high capacity modules on this parking canopy. Due to high structural costs associated with parking canopies, it generally makes sense to use high capacity modules to maximize the power output for a given canopy size.

APPENDIX Q: SITE ANALYSIS OF SCHOOL PARKING LOT C

Size: ~19,916 sq ft
Capacity: 144.3 kW_{DC}
Orientation: (South 174°), (West 285°)
Overall grade: B

Reasoning for grade:
Large parking lot size, south facing canopy, location within wetland buffer zone, high cost typical of parking canopies, minimal shading from trees located further from canopy, although they will continue to grow and shade the array over time.

Topography, stability, and access:
Site is flat, area is developed as an asphalt parking lot.

Cultural and historic importance:
Area is a parking lot near a public school.

Current usage:
Parking area for public school compound

Impacts on wildlife and surrounding habitat:
Minimal – area is paved.

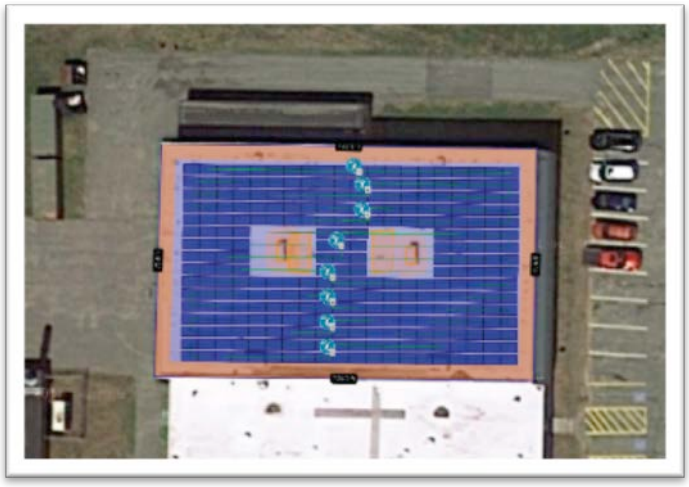
Concerns of neighbors, abutters, and others:
The site is in an area shrouded entirely by trees so there are no visibility concerns to neighbors.

Permitting, zoning, and regulatory considerations:
Wetlands permitting may be required.

Solar array technology:
It is recommended to use conventional high capacity modules on this parking canopy. Due to high structural costs associated with parking canopies, it generally makes sense to use high capacity modules to maximize the power output for a given canopy size.

APPENDIX R: SITE ANALYSIS OF SCHOOL BUILDING 1

Size: ~9,424 sq ft
Capacity: 82.1 kW_{DC}
Orientation: South (180°)
Overall grade: A



Reasoning for grade:
Large array area, south-facing array, no tree or building shading, no environmental concerns, Southern roof is lower so no shading issues from roof, roof membrane recently replaced.

Topography, stability, and access:
Roof is flat, roof updated in 2009, few vents as facility is a gym, area is well-developed.

Cultural and historic importance:
There is no immediately apparent cultural or historic importance of this structure.

Current usage:
Public school

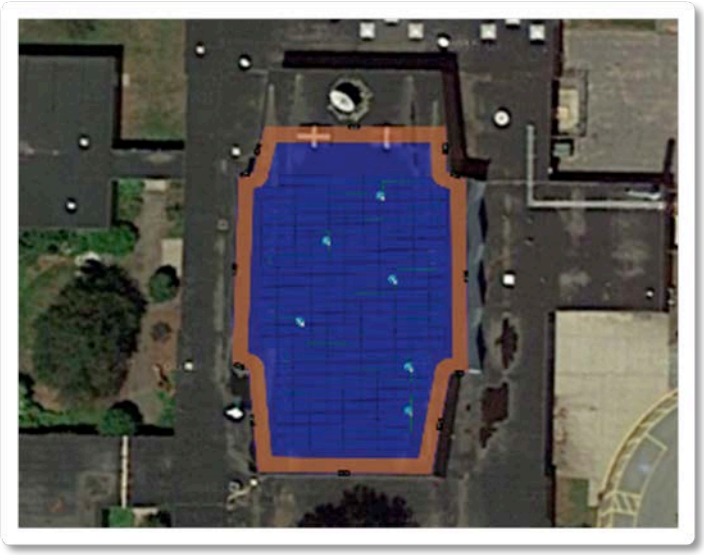
Impacts on wildlife and surrounding habitat:
There are no concerns to wildlife and the surrounding habitat regarding this roof-mounted array.

Concerns of neighbors, abutters, and others:
The site is in an area shrouded entirely by trees so there are no visibility concerns to neighbors.

Permitting, zoning, and regulatory considerations:
There are no permitting, zoning, regulatory, or environmental considerations regarding this roof-mounted PV array.

Solar array technology:
It is recommended to use conventional high capacity modules on this roof. Due to high labor costs, it generally makes sense to use higher wattage modules on small roof mount arrays such as this one.

APPENDIX S: SITE ANALYSIS OF SCHOOL BUILDING 2



Size: ~6,300 sq ft
Capacity: 62.7 kW_{DC}
Orientation: South (180°)
Overall grade: A

Reasoning for grade: Large array area, south-facing array, no tree or building shading, no environmental concerns, needs a new roof.

Topography, stability, and access:
Roof is flat, roof needs replacement, no obstructions, area is well-developed.

Cultural and historic importance:
There is no cultural or historic importance of this structure.

Current usage:
Public school

Impacts on wildlife and surrounding habitat:
There are no concerns to wildlife and the surrounding habitat regarding this roof mounted array.

Concerns of neighbors, abutters, and others:
The site is in an area surrounded entirely by trees so there are no visibility concerns to neighbors.

Permitting, zoning, and regulatory considerations:
There are no permitting, zoning, regulatory, or environmental considerations regarding this roof-mounted PV array.

Solar array technology:
It is recommended to use conventional high capacity modules on this roof. Due to high labor costs, it generally makes sense to use higher wattage modules on small roof mount arrays such as this one.

APPENDIX T: SITE ANALYSIS OF SCHOOL BUILDING 3

Size: ~13,677 sq ft
Capacity: 91.2 kW_{DC}
Orientation: South (180°)
Overall grade: A

Reasoning for grade:
Large array area, south-facing array, minor shading from trees on northwest side of building, no environmental concerns, needs new roof.

Topography, stability, and access:
Roof is flat, roof needs replacement, some obstructions on roof, area is well-developed.

Cultural and historic importance:
There is no cultural or historic importance of this structure.

Current usage:
Public school

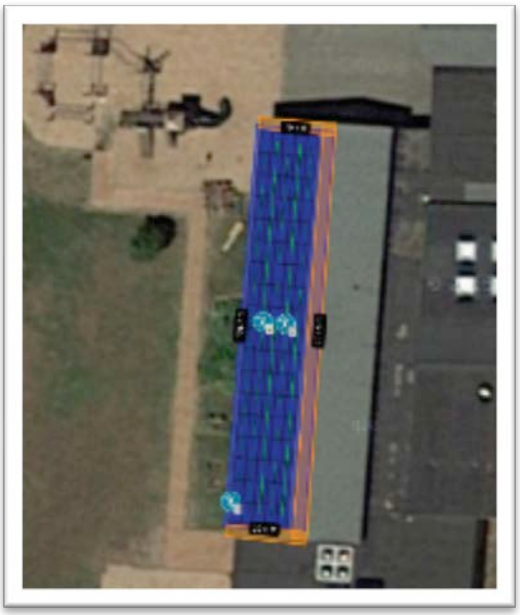
Impacts on wildlife and surrounding habitat:
There are no concerns to wildlife and the surrounding habitat regarding this roof-mounted array.

Concerns of neighbors, abutters, and others:
The site is in an area shrouded entirely by trees so there are no visibility concerns to neighbors.

Permitting, zoning, and regulatory considerations:
There are no permitting, zoning, regulatory, or environmental considerations regarding this roof-mounted PV array.

Solar array technology:
It is recommended to use conventional high capacity modules on this roof. Due to high labor costs, it generally makes sense to use higher wattage modules on small roof mount arrays such as this one.

APPENDIX U: SITE ANALYSIS OF SCHOOL BUILDING 4



Size: ~2,142 sq ft
Capacity: 25.7 kW_{DC}
Orientation: West (275°)
Overall grade: B

Reasoning for grade:
Small array area, not viable to orient array facing south, no shading concerns, no environmental concerns.

Topography, stability, and access:
Sloped flat roof, roof needs replacement, and area is well developed.

Cultural and historic importance:
There is no immediately apparent cultural or historic importance of this structure.

Current usage:
Public school

Impacts on wildlife and surrounding habitat:
There are no concerns to wildlife and the surrounding habitat regarding this roof mounted array.

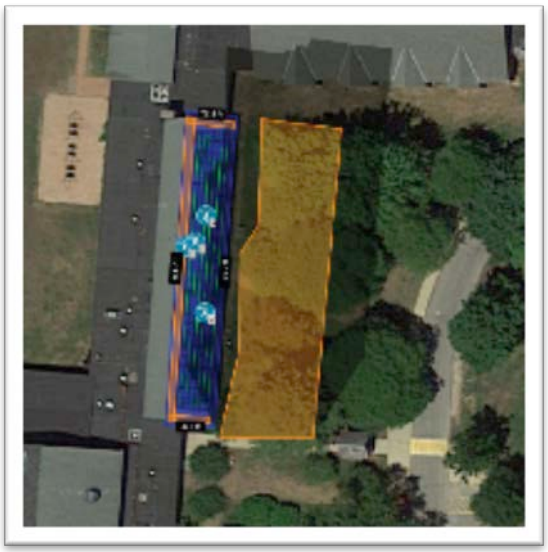
Concerns of neighbors, abutters, and others:
The site is in an area shrouded entirely by trees so there are no visibility concerns to neighbors.

Permitting, zoning, and regulatory considerations:
There are no permitting, zoning, regulatory, or environmental considerations regarding this roof mounted PV array.

Solar array technology:
It is recommended to use conventional high capacity modules on this roof. Due to high labor costs, it generally makes sense to use higher wattage modules on small roof mount arrays such as this one.

APPENDIX V: SITE ANALYSIS OF SCHOOL BUILDING 5

Size: ~4,000 sq ft
Capacity: 44.5 kW_{DC}
Orientation: East (94°)
Overall grade: C



Reasoning for grade:
Small array area, not viable to orient array facing south, shading concerns on east side, no environmental concerns.

Topography, stability, and access:
Sloped flat roof, roof needs replacement, and area is well-developed.

Cultural and historic importance:
There is no immediately apparent cultural or historic importance of this structure.

Current usage:
Public school

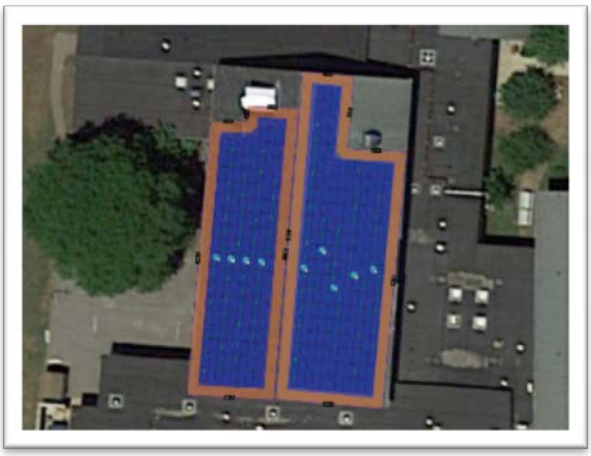
Impacts on wildlife and surrounding habitat:
There are no concerns to wildlife and the surrounding habitat regarding this roof-mounted array.

Concerns of neighbors, abutters, and others:
The site is in an area shrouded entirely by trees so there are no visibility concerns to neighbors.

Permitting, zoning, and regulatory considerations:
There are no permitting, zoning, regulatory, or environmental considerations regarding this roof-mounted PV array.

Solar array technology:
It is recommended to use conventional high capacity modules on this roof. Due to high labor costs, it generally makes sense to use higher wattage modules on small roof mount arrays such as this one.

APPENDIX W: SITE ANALYSIS OF SCHOOL BUILDING 6



Size: ~7,252 sq ft
Capacity: 94.1 kW_{DC}
Orientation: East (95°), West (275°)
Overall grade: B

Reasoning for grade:
Large array area, not viable to orient array facing south, possible shading from tree on west side of array, which may continue to grow, no environmental concerns.

Topography, stability, and access:
Sloped flat roof, roof needs replacement, and area is well developed.

Cultural and historic importance:
There is no cultural or historic importance of this structure.

Current usage:
Public school

Impacts on wildlife and surrounding habitat:
There are no concerns to wildlife and the surrounding habitat regarding this roof-mounted array.

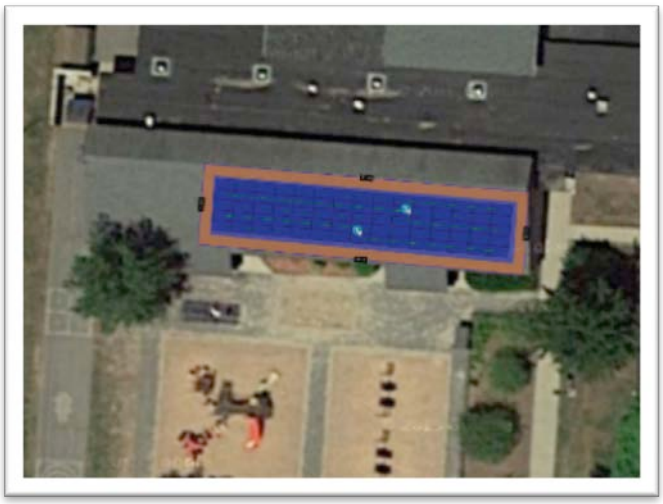
Concerns of neighbors, abutters, and others:
The site is in an area shrouded entirely by trees so there are no visibility concerns to neighbors.

Permitting, zoning, and regulatory considerations:
There are no permitting, zoning, regulatory, or environmental considerations regarding this roof-mounted PV array.

Solar array technology:
It is recommended to use conventional high capacity modules on this roof. Due to high labor costs, it generally makes sense to use higher wattage modules on small roof mount arrays such as this one.

APPENDIX X: SITE ANALYSIS OF SCHOOL BUILDING 7

Size: ~1,980 sq ft
Capacity: 21.4 kW_{DC}
Orientation: South (185°)
Overall grade: A



Reasoning for grade:
South-facing array, possible shading from tree on west and east sides of array but it was confirmed that they can be removed, no environmental concerns.

Topography, stability, and access:
Sloped flat roof, roof needs to be replaced, south-facing, tree on west side can be removed to make more area available for solar and area is well-developed.

Cultural and historic importance:
There is no cultural or historic importance of this structure.

Current usage:
Public school

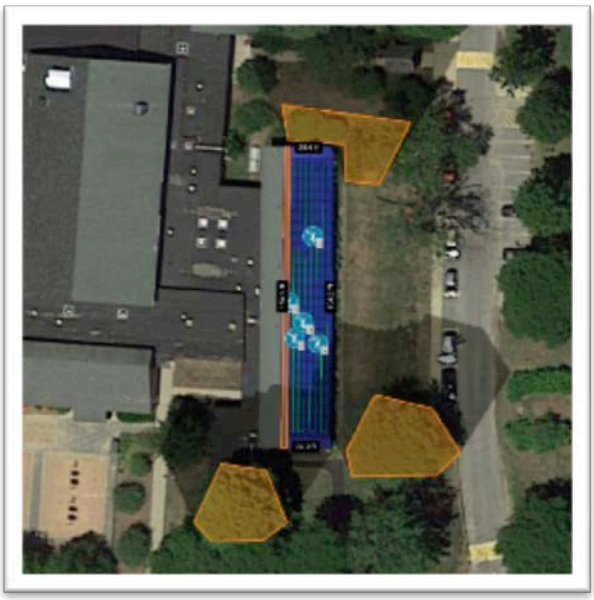
Impacts on wildlife and surrounding habitat:
There are no concerns to wildlife and the surrounding habitat regarding this roof-mounted array.

Concerns of neighbors, abutters, and others:
The site is in an area shrouded entirely by trees so there are no visibility concerns to neighbors.

Permitting, zoning, and regulatory considerations:
There are no permitting, zoning, regulatory, or environmental considerations regarding this roof-mounted PV array.

Solar array technology:
It is recommended to use conventional high capacity modules on this roof. Due to high labor costs, it generally makes sense to use higher wattage modules on small roof mount arrays such as this one.

APPENDIX Y: SITE ANALYSIS OF SCHOOL BUILDING 8



Size: ~3,850 sq ft
Capacity: 51.9 kW_{DC}
Orientation: East (90°)
Overall grade: B

Reasoning for grade:
Small array area, not viable to orient array facing south, few shading concerns, no environmental concern.

Topography, stability, and access:
Sloped flat roof, roof needs to be replaced, and area is well-developed.

Cultural and historic importance:
There is historic value of this structure to be considered.

Current usage:
Public school

Impacts on wildlife and surrounding habitat:
There are no concerns to wildlife and the surrounding habitat regarding this roof-mounted array.

Concerns of neighbors, abutters, and others:
The site is in an area shrouded entirely by trees so there are no visibility concerns to neighbors.

Permitting, zoning, and regulatory considerations:
There are no permitting, zoning, regulatory, or environmental considerations regarding this roof-mounted PV array.

Solar array technology:
It is recommended to use conventional high capacity modules on this roof. Due to high labor costs, it generally makes sense to use higher wattage modules on small roof mount arrays such as this one.

APPENDIX Z: SITE ANALYSIS OF SCHOOL BUILDING 9

Size: ~5,500 sq ft
Capacity: 27.4 kW_{DC}
Orientation: South (180°)
Overall grade: C

Reasoning for grade:
Small array area, south-facing array, no environmental concerns, tree to the south of the array will continue to grow and shade array with time. This is not a permanent structure and it would not make financial sense to install a system that will soon be removed.

Topography, stability, and access:
Roof is flat, roof needs to be replaced, and area is well-developed.

Cultural and historic importance:
There is no immediately apparent cultural or historic importance of this structure.

Current usage:
Public school

Impacts on wildlife and surrounding habitat:
There are no concerns to wildlife and the surrounding habitat regarding this roof-mounted array.

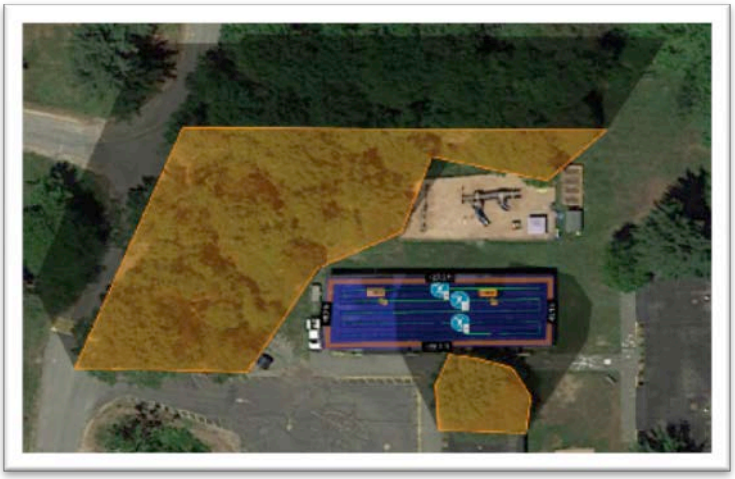
Concerns of neighbors, abutters, and others:
The site is in an area shrouded entirely by trees so there are no visibility concerns to neighbors.

Permitting, zoning, and regulatory considerations:
There are no permitting, zoning, regulatory, or environmental considerations regarding this roof-mounted PV array.

Solar array technology:
It is recommended to use conventional high capacity modules on this roof. Due to high labor costs, it generally makes sense to use higher wattage modules on small roof mount arrays such as this one.

APPENDIX AA: SITE ANALYSIS OF SCHOOL BUILDING 10

Size: ~5,100 sq ft
Capacity: 27.4 kW_{DC}
Orientation: South (180°)
Overall grade: C



Reasoning for grade:
Small array area, south-facing array, no environmental concerns, trees will continue to grow and shade array with time. This is not a permanent structure and it would not make financial sense to install a system that will soon be removed.

Topography, stability, and access:
Roof is flat, area is well developed, tree on South side will shade array

Cultural and historic importance:
There is no immediately apparent cultural or historic importance of this structure.

Current usage:
Public school

Impacts on wildlife and surrounding habitat:
There are no concerns to wildlife and the surrounding habitat regarding this roof-mounted array.

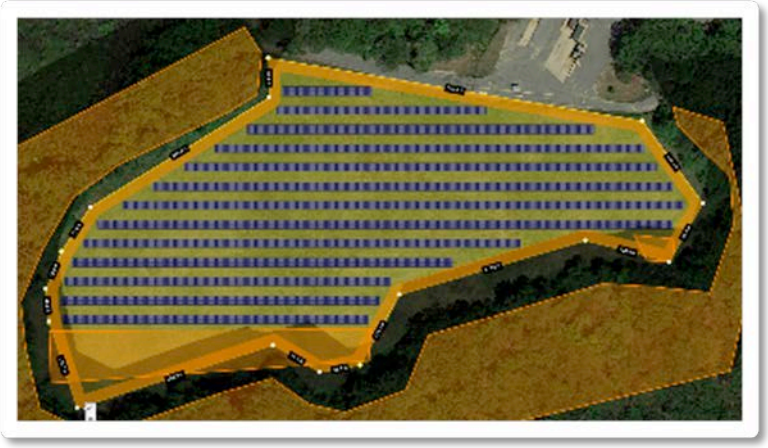
Concerns of neighbors, abutters, and others:
The site is in an area shrouded entirely by trees so there are no visibility concerns to neighbors.

Permitting, zoning, and regulatory considerations:
There are no permitting, zoning, regulatory, or environmental considerations regarding this roof-mounted PV array.

Solar array technology:
It is recommended to use conventional high capacity modules on this roof. Due to high labor costs, it generally makes sense to use higher wattage modules on small roof mount arrays such as this one.

APPENDIX BB: SITE ANALYSIS OF LANDFILL

Size: n/a
Capacity: 1,376 kW_{DC}
Orientation: South (180°)
Overall grade: A



Reasoning for grade:
Large south-facing array area. Town-owned. State promoting solar on landfills. No abutter visual impacts. Area is free of trees (except at perimeter). Field not a high-quality wildlife habitat.

Topography, stability, and access:
The Landfill is a large hill with sections facing in all directions. There is a portion of the southern section that is particularly steep. It will need to be determined how construction vehicles and the grid connection will access the site.

Cultural and historic importance:
There is no cultural or historic importance of the Landfill.

Current usage:
Open Space

Impacts on wildlife and surrounding habitat:
There are wetlands surrounding much of the Landfill that may limit the extent of a solar installation. The study completed for the site concluded there is no rare species habitat on the Landfill. Also, after installation wildlife and plant value, although diminished, will be retained.

Wetlands shown in blue

Concerns of neighbors, abutters, and others:
The site is in an area surrounded entirely by trees. However, the Landfill abuts the Minute Man National Historical Park, and there may be issues for the Park.

Permitting, zoning, and regulatory considerations:
Wetlands at the edges of the Landfill will make the filing of a Notice of Intent with the Conservation Commission a necessity if work is proposed with 100' of these resource areas.

Solar array technology:
It is recommended to use standard capacity modules on this land. Due to the large area having a slightly larger rating on the modules will not make a significant impact to the overall system cost.