B2Q Associates
100 Burtt Rd. Suite 212
Andover, MA 01810
(978) 208 – 0609
www.b2qassociates.com

August 7, 2023

Mr. Angus Jennings
Town Manager
Town of West Newbury
381 Main Street
West Newbury, MA 01985

RE: Solar Site Feasibility Screening Study Report

Dear Angus,

B2Q is pleased to provide this report summarizing our findings from this solar site feasibility screening study for the Town of West Newbury.

INTRODUCTION

B2Q was engaged by the Town of West Newbury to complete a screening study to review the potential to implement solar photovoltaic (PV) systems at seven potential locations, which were selected by the Town prior to commencing the study. We understand that the Town is interested in exploring the opportunity to expand their portfolio of solar PV systems in support of their goals to reduce their contribution to greenhouse gases and to provide renewable energy resources for the Town and its residents. As such, the primary goals of this screening assessment were to perform an initial, high-level engineering review of the technical and economic feasibility of installing solar PV system(s) at the seven (7) potential locations. The Town has two existing solar PV systems: the Main Street Solar Project (owned by 3rd party) and a ground-mount array at the DPW (owned by the Town). The Town has also been exploring the feasibility of a microgrid at the Municipal Campus, which is outside the scope of this study.

Solar PV panels convert sunlight into electricity. Strings of multiple PV panels form a PV array which are connected to one or more inverters to allow for the conversion of DC power to AC power. Electricity can be used by the customer to power building loads, or, in some cases, exported directly to the utility electric grid. If a solar PV system is qualified for net metering by the utility, then excess generation can be exported to the grid. Net meters can register both solar PV energy generated at the site and utility grid energy consumed by the site. The customer is billed only for the net energy, which is the energy generated less the energy consumed.

Solar PV arrays are commonly mounted in several different configurations, such as roof-mounted, ground-mounted, and canopy-mounted. Canopy-mounted arrays are often placed over parking lots to function as a carport, as well. Solar PV arrays are generally mounted at a fixed tilt angle, but solar tracking systems are available to allow the panels to rotate, either on a single-axis or dual-axis, to dynamically track the position of the sun throughout the day. Fixed tilt, ground-mounted arrays are generally the cheapest option, while carport canopy arrays are typically the most expensive.

EXECUTIVE SUMMARY

The table below summarizes the preliminary screening results and potential solar PV system characteristics for each location. Refer to subsequent sections of the report for more details on the high-level technical and economic screening reviews for each location.

Table 1: Executive Summary Table.

	Location	Mounting	Preliminary Solar PV System Size	Estimated Annual Solar PV Production	Estimated SMART Incentive Rate	Estimated Direct Ownership Economics				Estimated PPA	
						Order of Magnitude Construction Cost Estimate	Estimated Year 1 Net Cash Flow	Estimated 20-Year Net Present Value	Estimated Discounted Payback Period	Estimated Year 1 Net Cash Flow	Estimated 20-Year Net Present Value
-	-	-	kW AC	kWh	$/kWh	$	$	$	year	$	$
1.1	Housing Authority	Rooftop	133	170,400	-	$514,500	$70,518	$475,892	5	$53,089	$628,394
1.1	Housing Authority	Ground	33	49,837	-	$111,000	$21,366	$176,081	3	$16,999	$201,768
1.2	1910 Building	Parking Canopy	240	339,605	$0.017	$1,890,000	$144,706	$388,187	12	$63,821	$733,216
1.3	Public Safety Complex	Parking Canopy	30	49,617	$0.057	$266,000	$23,047	$84,549	10	$9,253	$106,263
1.4	Burnham Field	Parking Canopy	120	177,014	$0.017	$945,000	$75,208	$228,183	12	$32,945	$378,333
1.5	DPW & Pipestave Recreation	Rooftop	33	44,149	-	$129,500	$18,119	$124,219	5	$13,584	$160,767
1.5	DPW & Pipestave Recreation	Ground	24	39,688	$0.013	$86,400	$16,905	$139,765	3	$12,897	$153,005
1.5	DPW & Pipestave Recreation	Parking Canopy	480	774,705	-	$4,165,000	$315,880	$833,494	13	$144,054	$1,654,214
1.6	Page School	Ground	450	772,453	-	$1,620,000	$203,578	$1,272,290	6	$135,295	$1,590,771
1.7	North Dunn Field	Ground	300	480,886	-	$993,000	$196,768	$1,642,714	3	$154,166	$1,828,675
1.7	South Dunn Field	Ground	938	1,505,731	-	$3,300,000	$614,967	$4,992,348	3	$482,718	$5,725,875

KEY RESULTS & CONCLUSIONS

The following conclusions can be drawn from the executive summary table above:

1. Direct Ownership vs. 3rd Party Power Purchase Agreement (PPA): For each of the eleven potential solar PV systems considered across the seven locations, the screening and preliminary economic review indicate that a PPA would result in a higher 20-year net present value for the Town, compared to the Town directly purchasing and owning the system. The one exception to this conclusion is Location 1.3 Public Safety Complex canopy PV system, which indicates that the 20-year net present value would be slightly higher for the direct ownership path. This anomaly may be tied to the estimated SMART incentive, which is estimated to be higher than the other canopy PV systems considered in this study due to the G-2 utility rate structure used at this facility.

   Note that these conclusions are subject to change if the actual PPA offered by potential project developers is higher than the assumed PPA rates used in this study. We recommend the Town evaluate the potential procurement options to decide which is the preferred path, then solicit preliminary PPA proposals for review from developers, if 3rd party ownership is determined to be the preferred option. See the Key Assumptions & Methodology section later in this report for the assumed PPA and cost rates used in this screening study.

2. Incentives and Revenue Streams: Canopy solar PV systems at Location 1.2, 1.3, and 1.4 may be eligible to receive SMART incentives, largely due to the compensation rate adders for canopy systems, based on information published by the DOER. Solar PV systems under 25 kW AC, including the ground system considered at Location 1.5, may potentially be eligible for SMART incentives, as well. Rooftop, canopy, and ground systems over 25 kW AC are likely not eligible for SMART incentives. Additionally, behind the meter systems may be eligible to participate in other market programs, such as passive real-time demand response. We recommend the Town discuss the preliminary system concepts with applicable program representatives during the next phase of study/design, once the Town has prioritized which systems they are most interested in pursuing further.

   Federal investment tax credits (ITC) of up to 30% may be available to the Town in a direct ownership path through the Elective Pay option, or to a 3rd party project developer through the Transferability option, based on information published by the US IRS.

The matrix below summarizes the general favorable and unfavorable characteristics of each of the seven locations observed during this screening, to be considered by the Town while considering each site's compatibility for the installation of solar PV systems.

Table 2: Solar PV System Compatibility Summary.

Location	Favorable	Unfavorable
1.1 Housing Authority	• Physical space availability on roof and ground • Building interconnection phase = 3 phase • Solar PV could potentially be asset in future Municipal Campus microgrid	• Building interconnection voltage = 120/208V • Building electric infrastructure upgrades may be necessary to interconnect solar • SMART incentives unlikely
1.2 1910 Building	• Physical space availability over parking lot • Building interconnection phase = 3 phase • Solar PV could potentially be asset in future Municipal Campus microgrid • SMART incentives may be available due to canopy adder	• Building interconnection voltage = 120/208V
1.3 Public Safety Complex	• Building interconnection phase = 3 phase • Solar PV could potentially be asset in future Municipal Campus microgrid • SMART incentives may be available due to canopy adder	• Building interconnection voltage = 120/208V • Limited parking area space • High construction cost due to canopy steel and structures for small system size
1.4 Burnham Field	• Physical space availability over parking lot • Solar PV could be asset in potential future Municipal Campus microgrid • SMART incentives may be available due to canopy adder	• Building interconnection voltage and phase unknown • Small amount of local load
1.5 DPW & Pipestave Recreation	• Some amount of physical space availability on salt shed roof and ground	• Building interconnection voltage = 120/240V at DPW • Building interconnection phase = 1 phase at DPW • Small amount of local load at DPW

	• SMART incentives may be available for ground solar at DPW, if system is < 25 kW AC	• No existing local load at Pipestave Recreation • SMART incentives unlikely for rooftop solar at DPW • SMART incentives may not be available for canopy PV, due to lack of local loads • Salt shed structure may not be rated to support additional roof loads
1.6 Page School	• Physical space availability in unused field behind the school • Building interconnection phase = 3 phase • Large existing local load	• Building interconnection voltage = 120/208V • SMART incentives unlikely
1.7 Dunn Property	• Large amount of unused space	• No existing local load • No 3-phase utility power on Chase St. • SMART incentives may not be available, due to lack of local loads

Some additional general conclusions that can be drawn from this screening include:

- Building Interconnection Voltage and Phase: Most commercially available solar PV inverters output power at 480V, 3-phase. Each of the buildings considered in this study currently receives 208V, 3-phase power from the utility. Therefore, the solar PV systems may require a transformer to step-down the voltage to 208V between the inverter and the buildings' switchboard or panel. This is not necessarily a technical hurdle but could result in additional costs and should be investigated in more detail. Additionally, the DPW receives 240V, 1-phase power from the utility. Generally, the size of commercially available solar PV inverters outputting 1-phase power is limited, which may limit the size of potential behind the meter solar PV systems at Location 1.5. This could be studied further in the next phase of study and/or design, if the Town is interested in pursuing behind the meter solar PV at this site further.
- Building Interconnection Feasibility: The main switchboard or distribution panel in the buildings at Location 1.2, 1.3, and 1.6 were observed to have spare and/or blank positions, which potentially could be utilized to interconnect behind the meter solar PV systems. This should be studied further, and the interconnection strategy should be confirmed in the next phase of study and/or design.

KEY ASSUMPTIONS & METHODOLOGY

While reviewing the tables on the previous pages, please note the following:

1. The assumed direct ownership cost rates and 3rd party ownership PPA rates used in this study are shown in the table below. Assumed rates are based on industry-standard cost estimating guides, past experience, and industry metrics.

Table 3: Cost assumptions.

Cost Assumptions				
	Direct Ownership			PPA
Solar PV Type	Assumed Construction Cost Rate	Assumed Annual O&M Cost Rate	Assumed Utility Interconnection Cost Rate	Assumed 3rd Party PPA Rate
-	$/W DC	$/kW DC	$/W DC	$/kWh
Ground	$3.00	$18.00	$0.10	$0.10
Rooftop	$3.50		$0.10	$0.12
Canopy	$7.00		$0.10	$0.23

2. Estimated SMART program incentive rates were estimated using the "2023 SMART-BTM-Value-of-Energy-Workbook" tool, published by the Massachusetts Department of Energy Resources (DOER), for base compensation rates and applicable compensation rate adders[1]. In the direct ownership options, we assumed the Town would receive the SMART incentives directly, while in the PPA options we assumed SMART incentives would be retained by the 3rd party project developer. Note that the estimated incentive rates are subject to change and are anticipated to decrease in 2024.

3. The estimated economics for both the direct ownership and 3rd party Power Purchase Agreement (PPA) options assume that the Town would be eligible to receive net metering credits from National Grid, either as direct credits on the site's utility bill or as remote net metering credits towards another site's utility bill.

4. The estimated economics for the direct ownership option assumes that the Town would be eligible to receive a federal Investment Tax Credit (ITC) through the Elective Pay program. Based on available guidance published to date, we assumed the Town could receive a one-time, direct payment equal to 30% of the total project cost. Elective pay participants could be eligible for the 6% base rate, plus up to a 24% bonus for meeting the program's prevailing wage and apprenticeship requirements. The actual bonus amount will vary depending on the year the project is built and the project's ability to meet the program's domestic content requirements. Projects built in 2024 or beyond could be penalized if the domestic content requirements are not met.

[1] https://www.mass.gov/info-details/solar-massachusetts-renewable-target-smart-program

5. The estimated economics are based on a 20-year life cycle cost analysis (LCCA) assuming a 7% discount rate, 0.5% annual electric utility rate escalation, 2% annual PPA escalation, and 1% annual solar PV production degradation.

B2Q and the Town of West Newbury conducted a walkthrough of each location together on 5/11/2023 to observe the sites, discuss potential panel locations and configurations, and discuss potential electrical interconnection locations at a high-level. Electrical drawings were not available at the time of this report, therefore the information presented in this report is based on site observations and discussions with Town staff, only. Historical monthly electric utility data was provided by National Grid from January 2019 through March 2023.

Based on the Town's feedback, B2Q focused on one or more potential solar PV system configurations for each location. B2Q developed preliminary models for each system using HelioScope, an online solar energy modeling and simulation software, to screen one potential configuration for each location/system type and to demonstrate equipment layouts, system sizes, and predicted annual energy production for each. Physical obstructions and shading caused by these obstructions (i.e., trees, buildings, rooftop equipment) were considered in each model. The HelioScope reports can be found in Appendix A.

DISCLAIMERS

The preliminary budgetary opinions of probable construction costs are based on industry-standard cost estimating guides, past experience, and industry metrics, estimated on a $/W DC basis, which varies based on if the system is ground-mounted, roof-mounted, or a canopy carport. The opinions of probable cost presented in this report are a high-level view of the potential costs, intended to be estimates within +/- 30% of actual costs, and are not reflective of what would be produced by a detailed economic feasibility analysis.

Incentive estimates provided in this report, including federal investment tax credit (ITC) and Solar Massachusetts Renewable Target (SMART) incentives, are preliminary estimates based on information published online by sources such as the U.S. Department of Energy and the Massachusetts DOER. B2Q referenced the Value of Energy and Incentive Calculator for Behind-the-Meter facilities, which was developed by the DOER to provide customers with a practical tool to estimate the value of potential SMART incentives. B2Q has no control over the decisions of government agencies to provide incentives or tax credits. Since incentives and tax credits are entirely at the discretion of the government agency, B2Q does not expressly or implicitly warrant or represent that incentives or tax credits will be awarded. B2Q recommends coordinating with government agencies during subsequent study and design phases.

Net metering credit estimates provided in this report are preliminary estimates based on information published by National Grid in the Net Metering Provision M.D.P.U. No. 1331. B2Q has no control over the decisions of utility companies to provide net metering agreements or credits. Since net metering is entirely at the discretion of the utility, B2Q does not expressly or implicitly warrant or represent that net metering will be awarded. B2Q recommends coordinating with the utility during subsequent study and design phases to discuss current net metering allocations and caps.

Power purchase agreement (PPA) rate estimates assumed in this study are preliminary estimates made based on past experience, industry metrics, and information on existing PPA rates provided by the Town. B2Q has no control over the decisions of potential 3rd party project developers related to rate structures. Since PPAs are entirely at the discretion of the project developer, B2Q does not expressly or implicitly warrant or represent that PPAs will be awarded.

Interconnection related cost estimates provided in this report are preliminary estimates based on past experience and information published by the utilities, estimated on a $/W DC basis. B2Q has no control over the decisions of utility companies to provide an interconnection service agreement (ISA) or the related costs of interconnection. Since ISAs and related costs are entirely at the discretion of the utility, B2Q does not expressly or implicitly warrant or represent that an ISA will be awarded. B2Q recommends coordinating with the utility and initiating the ISA pre application process during subsequent study and design phases.

The Large Scale Ground Mounted Solar Photovoltaic Installations (LGSPI) map, indicating the utility's potential 3-phase capacity to host solar PV installations, was provided by West Newbury for B2Q to reference during this study. B2Q assumes that the information provided on this map is accurate, and B2Q does not expressly or implicitly warrant or represent that the utility has adequate capacity or that the utility will approve interconnection. Distributed generation interconnection feasibility and requirements are solely determined by the utility company, and B2Q recommends coordinating with the utility during subsequent study and design phases.

Recommended Next Steps

In summary, further planning and detailed engineering review are necessary in preparation for the next phases of design and construction of new solar PV systems. The recommended next steps are as follows:

- Internal review of screening report by Town stakeholders
- Present findings to additional Town stakeholders at joint Selectboard and Energy and Sustainability Committee meeting
- Town to prioritize select locations and solar PV system types to move forward to the next phase of study and design
- Town to consider their preferred project ownership path – Town-owned or 3rd party-owned with PPA and lease

We would be happy to meet with you to discuss any questions or comments you have on the above information. Thank you for the opportunity to work with you on this effort.

Sincerely,

Thomas Banks

Tom Banks, PE
Project Engineer
B2Q Associates

1.1 HOUSING AUTHORITY

EXISTING CONDITIONS

The Housing Authority is located on Parcel R14-6A, which is owned by the West Newbury Housing Authority, not the Town of West Newbury. The Annex, also located on Parcel R14-6A, is leased to the Town of West Newbury by the Housing Authority. The Annex and its electric loads are not included in the scope of this study.

Table 4: Location 1.1 existing electric service.

1.1 Housing Authority					
Electric Utility			Main Electric Service		
Account #	Meter #	Rate	Amps	Voltage	Phase
65732-60005	54239760	G1	800	120/208V	3

The Housing Authority's, and the 1910 Building's and Annex's, existing electrical service is provided via a National Grid 13.2 kV grid-Y /7.62 kV primary – 208 V Y / 120 V secondary service, pad mount utility transformer located by the 1910 Building's front parking lot to the east of the building. The building's main service entry gear is located at ground level in an electric/boiler room. The existing service entrance switchboard is 800A, 3 phase, 4 wire, 208Y/120VAC. The existing main distribution panel does not appear to have available spare positions. Based on field observations, it appears that the Annex is served by the same electric service, but has its own distribution panels, which are sub-metered.

The Large Scale Ground Mounted Solar Photovoltaic Installations (LGSPI) map provided by West Newbury indicates the National Grid primary feeder in the immediate vicinity of the building along Main Street may have sufficient 3-phase capacity to host a solar PV installation.

The graph below shows the building's historical monthly electricity use. Estimates of monthly use were made as required to account for billing or metering errors. Monthly electricity use is relatively consistent from month to month, with a slight increase during the summer months. No usage was reported from June 2022 to August 2022, which may be attributed to a meter error. Based on conversations with town representatives, the electric data shown below is for the Housing Authority, only, and the Annex has a separate electric utility account.

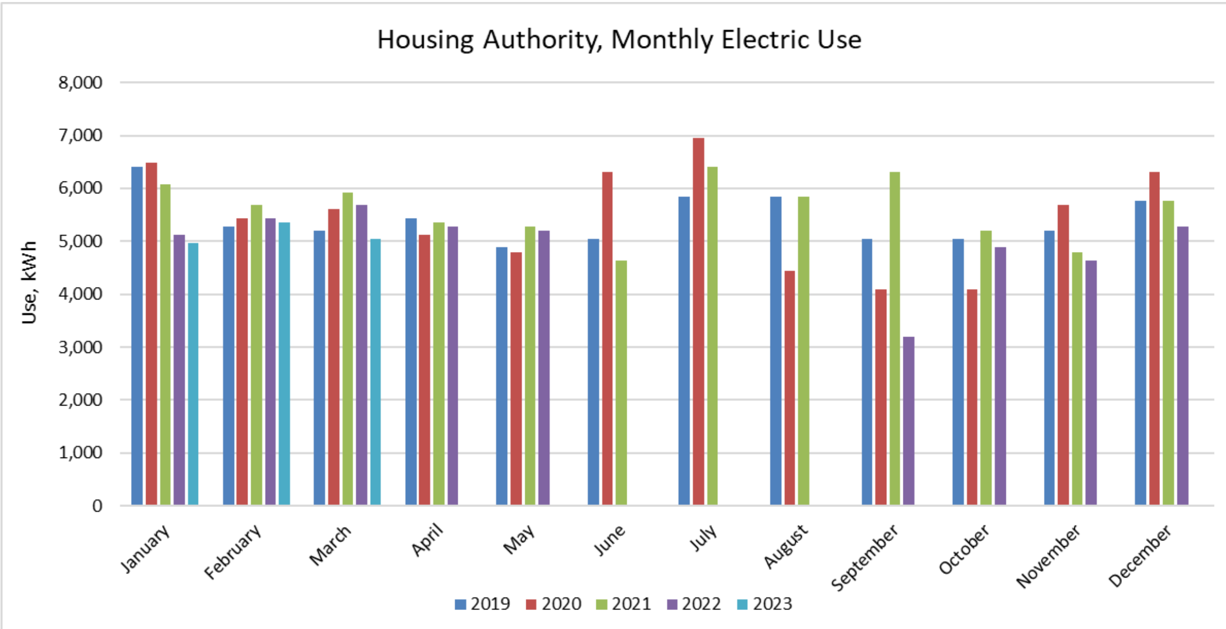


Figure 1: Location 1.1 monthly electricity use.

SOLAR PV REVIEW

TECHNICAL SCREENING

Rooftop solar PV and ground-mount solar PV systems were considered in this screening study. The small parking lot to the west of the building was not considered for canopy parking lot solar PV in this study due to its size limitations and the availability of rooftop and ground space at this site. Based on conversations with town staff, the roof was replaced roughly 7 years ago. It is recommended to engage a licensed professional structural engineer to assess the condition and suitability of the roof to support a roof-mounted solar PV systems as part of a future phase of study and/or design.

The preliminary screening results, including AC nameplate power, monthly and annual electricity generation, and panel layouts, for the rooftop and ground-mount solar PV systems are shown in the tables and figures below. The rooftop system was modeled at a 5° tilt angle and an azimuth angle parallel to the lengthwise roof edge. The ground-mount system was modeled at a 30° tilt angle and an azimuth angle of 180°, which is south-facing.

Table 5: Location 1.1 Solar PV Screening Summary.

1.1 Housing Authority			
Location	Mounting	Preliminary Inverter AC Nameplate kW	Estimated Annual Energy Generation kWh
Building	Rooftop	133	170,400
Open Space	Ground	33	49,837

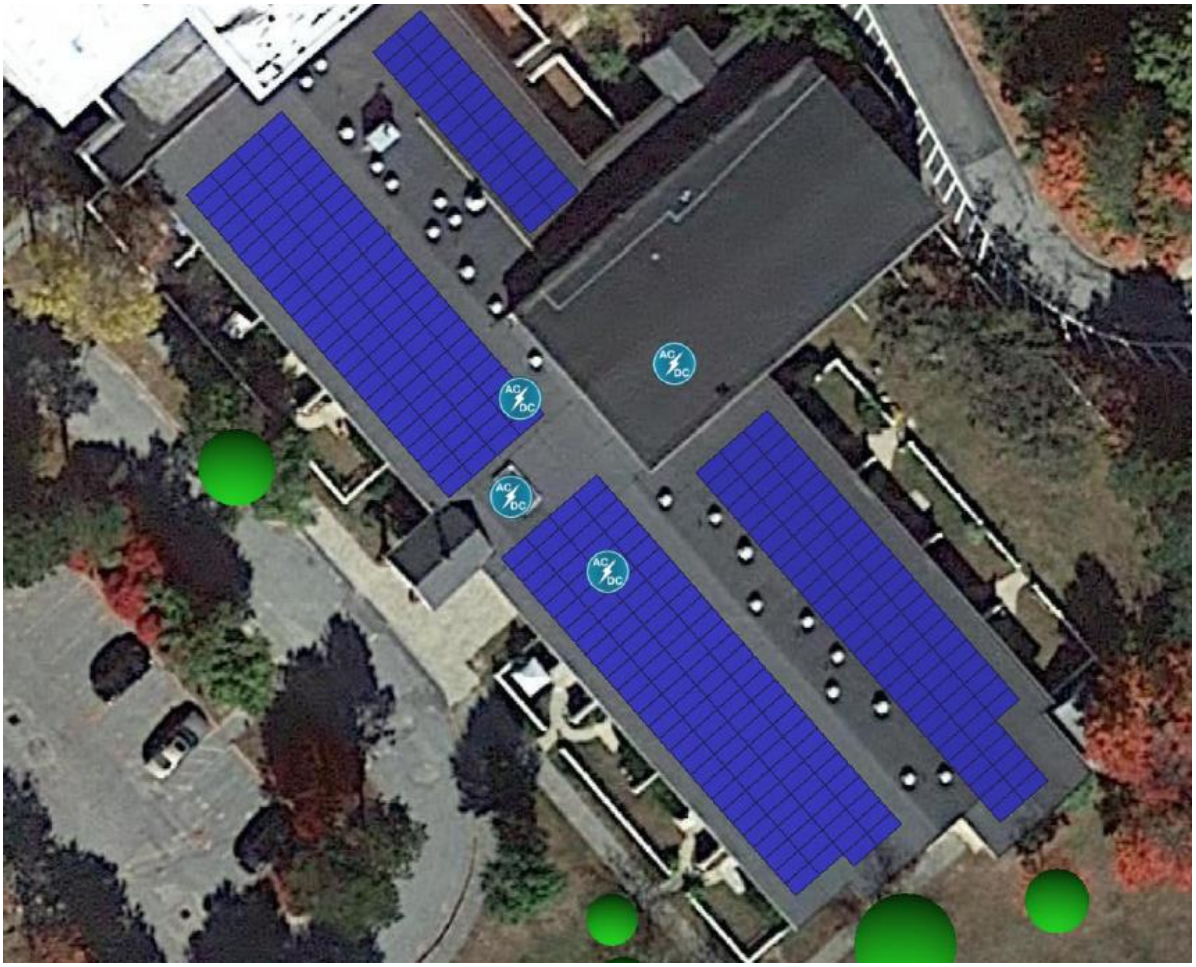


Figure 2: Location 1.1 Panel Layout – Rooftop.

Table 6: Location 1.1 Monthly Energy Generation – Rooftop.

1.1 Housing Authority - Roof	
Month	Predicted Solar PV Generation
January	7,428
February	10,283
March	15,860
April	17,742
May	20,116
June	19,895
July	21,535
August	18,540
September	15,151
October	10,798
November	7,387
December	5,665
Total	**170,400**

Figure 3: Location 1.1 Panel Layout – Ground-Mount.

Table 7: Location 1.1 Monthly Energy Generation – Ground-Mount.

1.1 Housing Authority - Ground	
Month	Predicted Solar PV Generation
January	2,420
February	3,572
March	5,201
April	5,043
May	5,263
June	4,994
July	5,584
August	5,163
September	4,742
October	3,745
November	2,388
December	1,722
Total	**49,837**

ECONOMIC SCREENING

The high level opinions of probable cost and incentives, and the preliminary life cycle cost analysis for the system(s) considered at this location are summarized in the table below.

Table 8: Location 1.1 Preliminary Economic Summary.

Mounting	Estimated SMART Incentive Rate	Estimated Direct Ownership Economics				Estimated PPA	
		Order of Magnitude Construction Cost Estimate	Estimated Year 1 Net Cash Flow	Estimated 20-Year Net Present Value	Estimated Discounted Payback Period	Estimated Year 1 Net Cash Flow	Estimated 20-Year Net Present Value
-	$/kWh	$	$	$	year	$	$
Rooftop	-	$514,500	$70,518	$475,892	5	$53,089	$628,394
Ground	-	$111,000	$21,366	$176,081	3	$16,999	$201,768

The potential SMART incentive rates were estimated based on the following information gathered from the "2023 SMART-BTM-Value-of-Energy-Workbook":

Rooftop System:

- G-1 Rate Class, Net-Metered Value of Energy = $0.21144
- Greater than 25 kW AC to 250 kW AC, Block 10 Base Compensation Rate = $0.16847/kWh
- Building Mounted Solar Tariff Generation Unit, Compensation Rate Adder = $0.0192/kWh
- Base Compensation Rate + Compensation Rate Adder – Value of Energy = **Estimated SMART Incentive = $0.00/kWh**

Ground-Mount System:

- G-1 Rate Class, Net-Metered Value of Energy = $0.21144
- Greater than 25 kW AC to 250 kW AC, Block 10 Base Compensation Rate = $0.16847/kWh
- No Compensation Rate Adders
- Base Compensation Rate + Compensation Rate Adder – Value of Energy = **Estimated SMART Incentive = $0.00/kWh**

1.2 1910 BUILDING

EXISTING CONDITIONS

The 1910 Building is located on Parcel R14-6, which is owned by the Town of West Newbury. The front parking lot is located on the same parcel, while the back parking lot, located to the southeast, is located on Parcel 14-4A, which is also owned by the Town of West Newbury.

Table 9: Location 1.2 existing electric service.

1.2 1910 Building					
Electric Utility			Main Electric Service		
Account #	Meter #	Rate	Amps	Voltage	Phase
53271-88004	25140301	G1	800	120/208V	3

The 1910 Building's, and the Housing Authority's and Annex's, existing electrical service is provided via a National Grid 13.2 kV grid-Y /7.62 kV primary – 208 V Y / 120 V secondary service, pad mount utility transformer located by the 1910 Building's front parking lot to the east of the building. The building's main service entry gear is located in the basement in an electric room. The existing service entrance switchboard is 800A, 3 phase, 4 wire, 208Y/120VAC. The existing main distribution panel appears to have available spare positions.

The LGSPI map provided by West Newbury indicates the National Grid primary feeder in the immediate vicinity of the building along Main Street may have sufficient 3-phase capacity to host a solar PV installation.

The graph below shows the building's historical monthly electricity use. Estimates of monthly use were made as required to account for billing or metering errors. Monthly electricity use is relatively consistent from month to month, with a slight increase during the summer months.

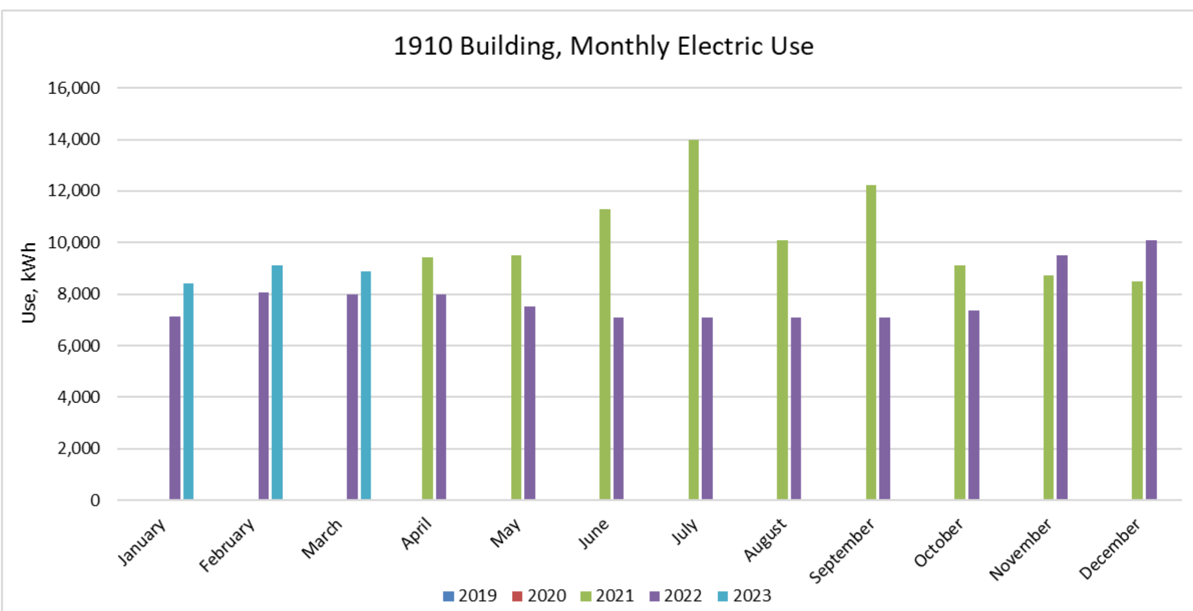


Figure 4: Location 1.2 monthly electricity use.

SOLAR PV REVIEW

TECHNICAL SCREENING

A canopy parking lot solar PV system over the back parking lot was considered in this screening study. The front parking lot was not considered due to aesthetic concerns related to its proximity to Main Street. Rooftop solar PV and ground-mount solar PV were not considered in this study due to the limited space availability. It is recommended to engage a licensed geotechnical engineer to assess the condition and suitability of the subsurface conditions to support canopy solar PV systems as part of a future phase of study and/or design.

The preliminary screening results, including AC nameplate power, monthly and annual electricity generation, and panel layouts, for the canopy parking solar PV system are shown in the tables and figure below. The canopy parking lot solar PV system was modeled at a 7° tilt angle and an azimuth angle to match the direction of the parking spaces.

Table 10: Location 1.2 Solar PV Screening Summary.

1.2 1910 Building			
Location	Mounting	Preliminary Inverter AC Nameplate kW	Estimated Annual Energy Generation kWh
Parking Lot	Canopy	240	339,605

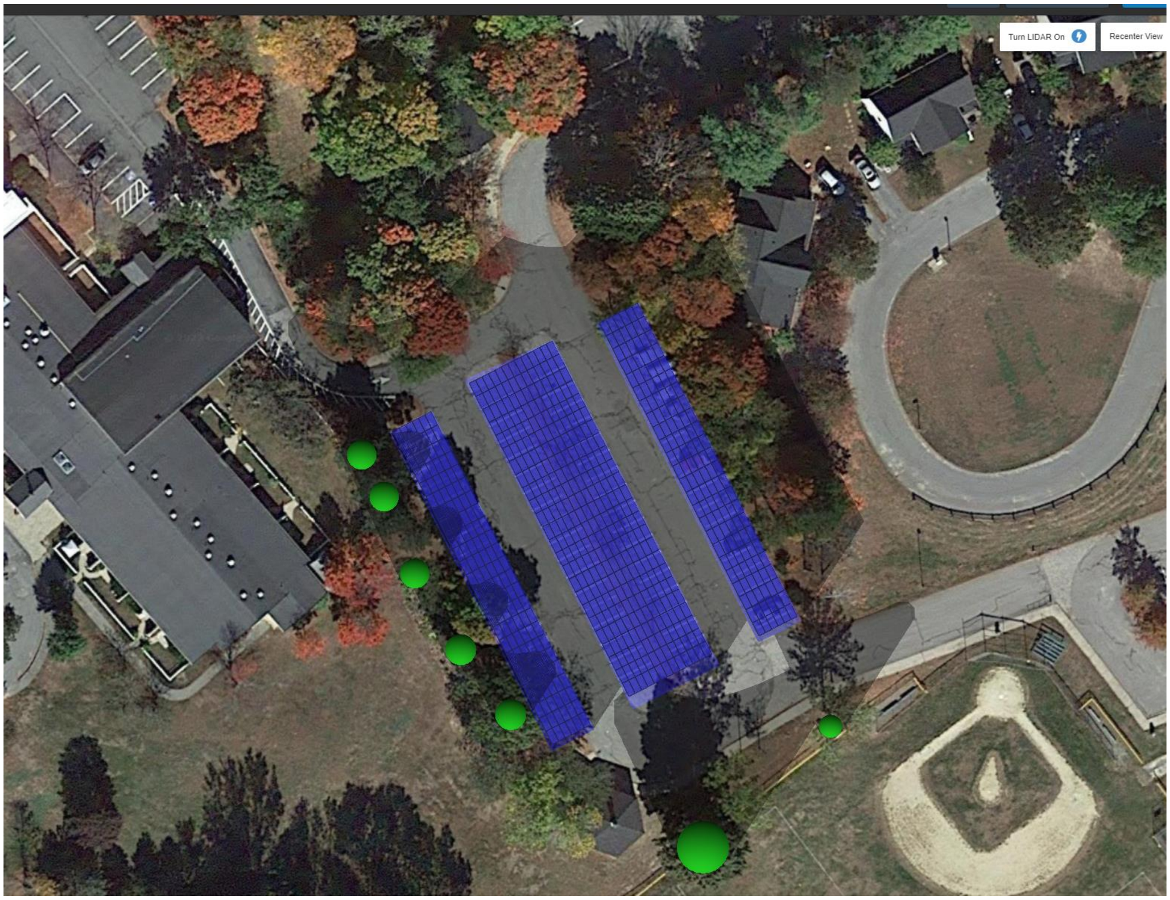


Figure 5: Location 1.2 Panel Layout – Canopy Parking.

Table 11: Location 1.2 Monthly Energy Generation – Canopy Parking.

1.2 1910 Building - Parking Canopy	
Month	Predicted Solar PV Generation
January	15,356
February	20,647
March	31,497
April	34,961
May	39,892
June	39,287
July	42,713
August	36,889
September	30,104
October	21,500
November	15,009
December	11,750
Total	**339,605**

ECONOMIC SCREENING

The high level opinions of probable cost and incentives and the preliminary life cycle cost analysis for the system(s) considered at this location are summarized in the table below.

Table 12: Location 1.2 Preliminary Economic Summary.

Mounting	Estimated SMART Incentive Rate	Estimated Direct Ownership Economics				Estimated PPA	
		Order of Magnitude Construction Cost Estimate	Estimated Year 1 Net Cash Flow	Estimated 20-Year Net Present Value	Estimated Discounted Payback Period	Estimated Year 1 Net Cash Flow	Estimated 20-Year Net Present Value
-	$/kWh	$	$	$	year	$	$
Parking Canopy	$0.017	$1,890,000	$144,706	$388,187	12	$58,094	$670,971

The potential SMART incentive rate was estimated based on the following information gathered from the "2023 SMART-BTM-Value-of-Energy-Workbook":

<u>Canopy Carport System:</u>

- G-1 Rate Class, Net-Metered Value of Energy = $0.21144
- Greater than 25 kW AC to 250 kW AC, Block 10 Base Compensation Rate = $0.16847/kWh
- Canopy Solar Tariff Generation Unit, Compensation Rate Adder = $0.06/kWh
- Base Compensation Rate + Compensation Rate Adder – Value of Energy = **Estimated SMART Incentive = $0.017/kWh**

1.3 Public Safety Complex

Existing Conditions

The Public Safety Complex, home to the police and fire station, is located on Parcel R14-3, which is owned by the Town of West Newbury.

Table 13: Location 1.3 existing electric service.

1.3 Public Safety Building					
Electric Utility			Main Electric Service		
Account #	Meter #	Rate	Amps	Voltage	Phase
15932-97003	25056615	G2	1200	120/208V	3

The Public Safety Complex's existing electrical service is provided via a National Grid primary to secondary service, pad mount utility transformer located to the east of the building. The transformer nameplate did not provide the size of the transformer. The building's main service entry gear is located in an electric room on the first floor. The existing service entrance switchboard is 1200A, 3 phase, 4 wire, 208Y/120VAC. The existing main distribution panel appears to have two spare, 100A positions.

The LGSPI map provided by West Newbury indicates the National Grid primary feeder in the immediate vicinity of the building along Main Street may have sufficient 3-phase capacity to host a solar PV installation.

The graph below shows the building's historical monthly electricity use. Monthly electricity use is typically highest in the winter and summer months. Monthly usage in January through March 2023 is noticeably lower than previous years, which may be attributed to energy conservation efforts or changes in building occupancy.

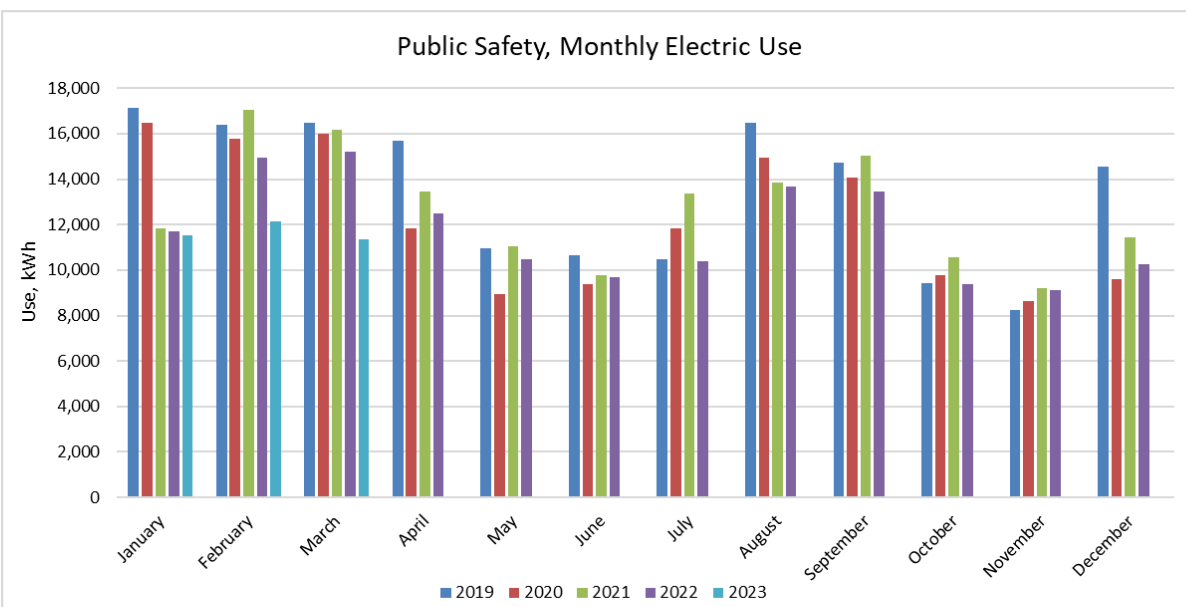


Figure 6: Location 1.3 monthly electricity use.

SOLAR PV REVIEW

TECHNICAL SCREENING

A canopy parking lot solar PV system over the parking lot to the south of the building was considered in this screening study. The spaces closest to the building were not included due to their proximity to the building. Rooftop solar PV and ground-mount solar PV were not considered in this study due to the limited space availability. It is recommended to engage a licensed geotechnical engineer to assess the condition and suitability of the subsurface conditions to support canopy solar PV systems as part of a future phase of study and/or design.

The preliminary screening results, including AC nameplate power, monthly and annual electricity generation, and panel layouts, for the canopy parking solar PV system are shown in the tables and figure below. The canopy parking lot solar PV system was modeled at a 7° tilt angle and an azimuth angle to match the direction of the parking spaces.

Table 14: Location 1.3 Solar PV Screening Summary.

1.3 Public Safety Complex			
Location	Mounting	Preliminary Inverter AC Nameplate kW	Estimated Annual Energy Generation kWh
Parking Lot	Canopy	30	49,617

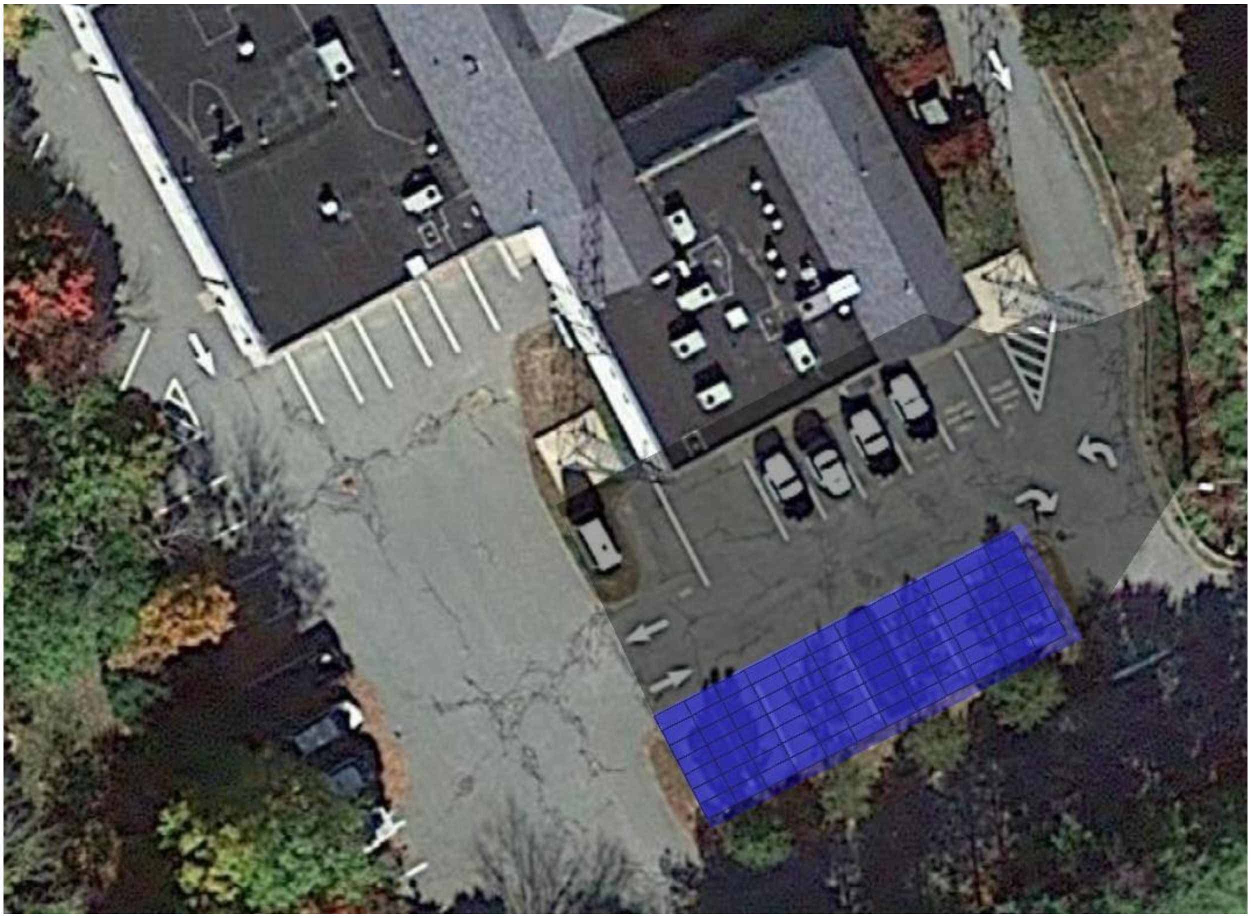


Figure 7: Location 1.3 Panel Layout – Canopy Parking.

Table 15: Location 1.3 Monthly Energy Generation – Canopy Parking.

1.3 Public Safety Complex - Parking Canopy	
Month	Predicted Solar PV Generation
January	2,431
February	3,142
March	4,644
April	5,050
May	5,608
June	5,541
July	6,086
August	5,282
September	4,415
October	3,258
November	2,291
December	1,869
Total	**49,617**

Economic Screening

The high level opinions of probable cost and incentives and the preliminary life cycle cost analysis for the system(s) considered at this location are summarized in the table below.

Table 16: Location 1.3 Preliminary Economic Summary.

Mounting	Estimated SMART Incentive Rate	Estimated Direct Ownership Economics				Estimated PPA	
		Order of Magnitude Construction Cost Estimate	Estimated Year 1 Net Cash Flow	Estimated 20-Year Net Present Value	Estimated Discounted Payback Period	Estimated Year 1 Net Cash Flow	Estimated 20-Year Net Present Value
-	$/kWh	$	$	$	year	$	$
Parking Canopy	$0.057	$266,000	$23,047	$84,549	10	$6,465	$75,970

The potential SMART incentive rate was estimated based on the following information gathered from the "2023 SMART-BTM-Value-of-Energy-Workbook":

<u>Canopy Carport System:</u>

- G-2 NEMA Rate Class, Net-Metered Value of Energy = $0.17173
- Greater than 25 kW AC to 250 kW AC, Block 10 Base Compensation Rate = $0.16847/kWh
- Canopy Solar Tariff Generation Unit, Compensation Rate Adder = $0.06/kWh
- Base Compensation Rate + Compensation Rate Adder – Value of Energy = **Estimated SMART Incentive = $0.057/kWh**

1.4 Burnham Field

Existing Conditions

Burnham Field, also known as Bachelor Street Field, and its parking lot is located on Parcel R14-3B, which is owned by the Town of West Newbury.

Table 17: Location 1.4 existing electric service.

1.4 Burnham Field					
Electric Utility			Main Electric Service		
Account #	Meter #	Rate	Amps	Voltage	Phase
50510-96019	93336179	G1	N/A	N/A	N/A

There is a small building at Burnham Field referred to as the snack shack. The snack shack was locked during the site walkthrough; therefore, the characteristics of the main service entry gear were unknown at the time of this report.

The LGSPI map provided by West Newbury indicates the National Grid primary feeder in the immediate vicinity of the building along Bachelor Street may have sufficient 3-phase capacity to host a solar PV installation.

The graph below shows the snack shack's historical monthly electricity use. Monthly electricity is relatively consistent from year to year. The building uses less than 2,000 kWh of electricity per year. Monthly usage increases during the summer months, likely correlating to more frequent use of the ball fields.

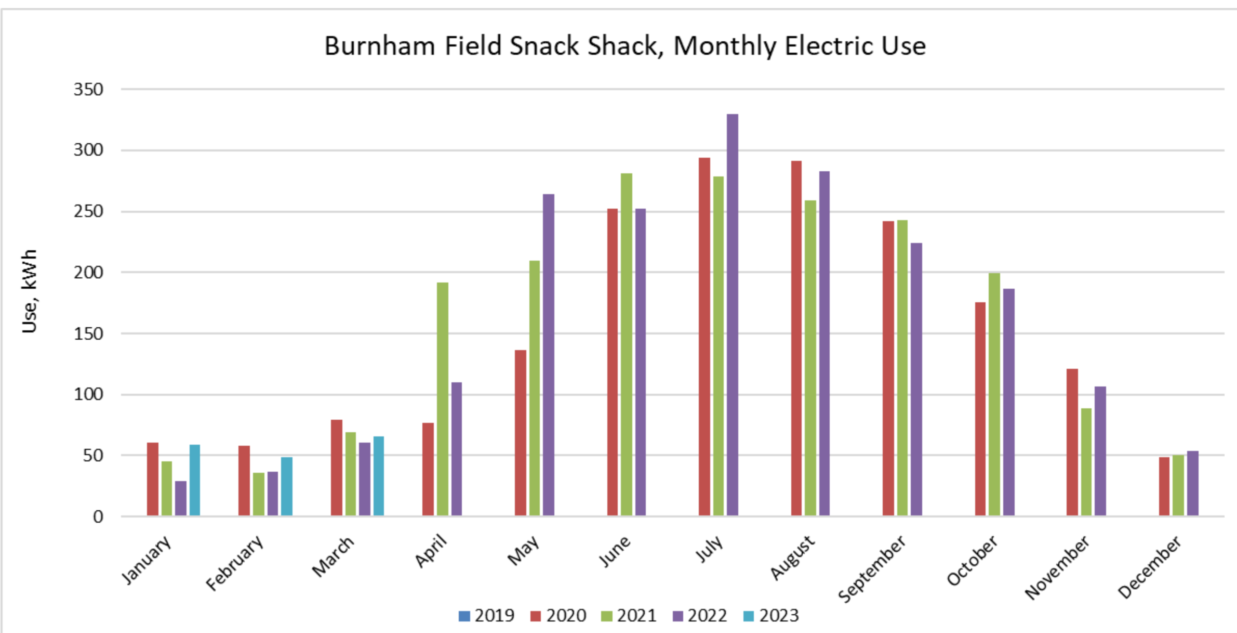


Figure 8: Location 1.4 monthly electricity use.

SOLAR PV REVIEW

TECHNICAL SCREENING

A canopy parking lot solar PV system over the parking lot was considered in this screening study. Rooftop solar PV and ground-mount solar PV were not considered in this study due to the limited space availability and town preferences. It is recommended to engage a licensed geotechnical engineer to assess the condition and suitability of the subsurface conditions to support canopy solar PV systems as part of a future phase of study and/or design.

The preliminary screening results, including AC nameplate power, monthly and annual electricity generation, and panel layouts, for the canopy parking solar PV system are shown in the tables and figure below. The canopy parking lot solar PV system was modeled at a 7° tilt angle and an azimuth angle to match the direction of the parking spaces.

Table 18: Location 1.4 Solar PV Screening Summary.

1.4 Burnham Field			
Location	Mounting	Preliminary Inverter AC Nameplate kW	Estimated Annual Energy Generation kWh
Parking Lot	Canopy	120	177,014

Figure 9: Location 1.4 Panel Layout – Canopy Parking.

Table 19: Location 1.4 Monthly Energy Generation – Canopy Parking.

1.4 Burnham Field - Parking Canopy	
Month	Predicted Solar PV Generation
January	8,680
February	11,211
March	16,563
April	18,106
May	20,138
June	19,757
July	21,615
August	18,779
September	15,710
October	11,601
November	8,184
December	6,670
Total	**177,014**

ECONOMIC SCREENING

The high level opinions of probable cost and incentives and the preliminary life cycle cost analysis for the system(s) considered at this location are summarized in the table below.

Table 20: Location 1.4 Preliminary Economic Summary.

Mounting	Estimated SMART Incentive Rate	Estimated Direct Ownership Economics				Estimated PPA	
		Order of Magnitude Construction Cost Estimate	Estimated Year 1 Net Cash Flow	Estimated 20-Year Net Present Value	Estimated Discounted Payback Period	Estimated Year 1 Net Cash Flow	Estimated 20-Year Net Present Value
-	$/kWh	$	$	$	year	$	$
Parking Canopy	$0.017	$945,000	$75,208	$228,183	12	$29,960	$345,889

The potential SMART incentive rate was estimated based on the following information gathered from the "2023 SMART-BTM-Value-of-Energy-Workbook":

<u>Canopy Carport System:</u>

- G-1 Rate Class, Net-Metered Value of Energy = $0.21144
- Greater than 25 kW AC to 250 kW AC, Block 10 Base Compensation Rate = $0.16847/kWh
- Canopy Solar Tariff Generation Unit, Compensation Rate Adder = $0.06/kWh
- Base Compensation Rate + Compensation Rate Adder – Value of Energy = **Estimated SMART Incentive = $0.017/kWh**

1.5 DPW GARAGE & PIPESTAVE RECREATION AREA

EXISTING CONDITIONS

The Department of Public Works (DPW) Garage, and salt shed, is located on Parcel R22-3, which is owned by the Town of West Newbury. This 200+ acre parcel of land is also home to the Pipestave Recreation Area, which is part of the greater Mill Pond Recreation Area. The recreation area includes a horseback riding ring, ball fields, and trails. The parcel is considered to be a high conservation priority area by the Town.

Table 21: Location 1.5 existing electric service.

1.5 DPW Garage					
Electric Utility			Main Electric Service (each, qty. 2)		
Account #	Meter #	Rate	Amps	Voltage	Phase
13106-14004	12470672	G1	200	120/240V	1

The DPW's existing electrical service is provided by National Grid. The utility transformer was not observed during the walkthrough. The building's main service entry gear is located on the building's east-facing exterior wall. The building has (2) 200A, 1-phase, 3 wire, 120/240VAC distribution panels located in the electric room inside on the first floor. The building's service is provided by two sources: National Grid's utility electric service and a customer-owned, ground-mount solar PV system. There is a net meter located on the building's east-facing exterior wall, as well. The existing solar PV system is designed for approximately 3.4 kW DC based on the panel nameplate ratings observed in the field. DC power is converted to AC power via a Solectria inverter located beneath the array. An inverter nameplate was not observed during the walkthrough to confirm the AC power rating.

The LGSPI map provided by West Newbury indicates the National Grid primary feeder in the immediate vicinity of the building along Main Street may have sufficient 3-phase capacity to host a solar PV installation.

The graph below shows the building's historical monthly electricity use. Note that the usage data shown below is assumed to be the building's net metered utility electricity use and does not include the electricity use from the solar PV system generation. Monthly electricity use is somewhat inconsistent and is typically highest in February and September.

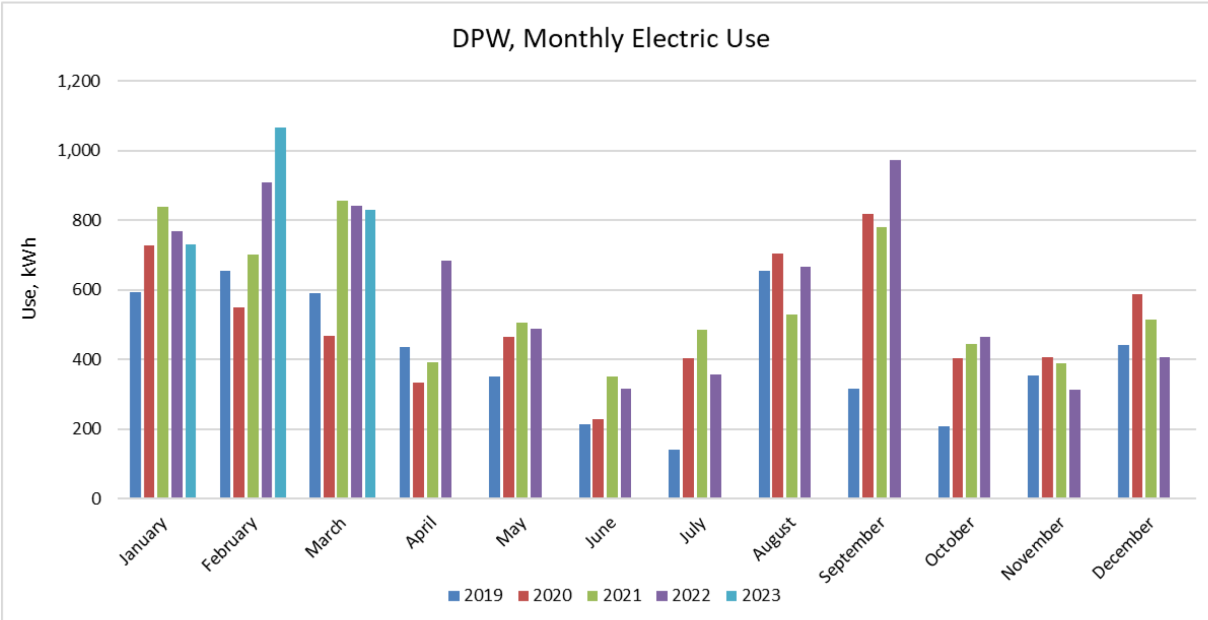


Figure 10: Location 1.5 monthly electricity use.

SOLAR PV REVIEW

TECHNICAL SCREENING

Rooftop solar PV on the salt shed and ground-mount solar PV systems were considered in this screening study at the DPW Garage. Rooftop solar PV on the garage itself was not considered in this study due to the town's concerns with the condition of the roof. It is recommended to engage a licensed professional structural engineer to assess the condition and suitability of the salt shed roof to support a roof-mounted solar PV systems as part of a future phase of study and/or design. The salt shed's structure may not be rated to support additional roof loads. Additionally, large-span canopy parking lot solar PV was considered by the Pipestave Recreation Area. It is recommended to engage a licensed geotechnical engineer to assess the condition and suitability of the subsurface conditions to support canopy solar PV systems as part of a future phase of study and/or design.

The preliminary screening results, including AC nameplate power, monthly and annual electricity generation, and panel layouts, for the solar PV systems are shown in the tables and figures below. The rooftop system was modeled at a 12° tilt angle on the lower section and a 20° tilt angle on the upper section, to match the estimated roof pitch, and an azimuth angle parallel to the lengthwise roof edge. The ground-mount system was modeled at a 30° tilt angle and an azimuth angle of 180°, which is south-facing. The canopy parking lot solar PV system was modeled at a 7° tilt angle and an azimuth angle to match the direction of the parking spaces.

Another potential option the Town may wish to consider in the future is the potential to replace, and potentially upsize, the existing ground-mount system at the site, instead of installing a second, new system. The Evergreen panels observed in the field are each rated for 210 W DC.

Panel technology has since advanced, with more efficient panels rated for 300 – 400 W DC available.

Table 22: Location 1.5 Solar PV Screening Summary.

1.5 DPW Garage / Pipestave Recreation Area			
Location	Mounting	Preliminary Inverter AC Nameplate kW	Estimated Annual Energy Generation kWh
Salt Shed	Rooftop	33	44,149
Open Space	Ground	24	39,688
Parking Lot	Canopy	480	774,705

Figure 11: Location 1.5 Panel Layout – Rooftop.

Table 23: Location 1.5 Monthly Energy Generation – Rooftop.

1.5 DPW Garage - Salt Shed Roof	
Month	Predicted Solar PV Generation
January	2,577
February	3,064
March	4,180
April	4,307
May	4,658
June	4,573
July	4,996
August	4,452
September	3,897
October	3,099
November	2,337
December	2,009
Total	**44,149**

Figure 12: Location 1.5 Panel Layout – Ground-Mount.

Table 24: Location 1.5 Monthly Energy Generation – Ground-Mount.

1.5 DPW Garage - Salt Shed Roof	
Month	Predicted Solar PV Generation
January	2,577
February	3,064
March	4,180
April	4,307
May	4,658
June	4,573
July	4,996
August	4,452
September	3,897
October	3,099
November	2,337
December	2,009
Total	**44,149**

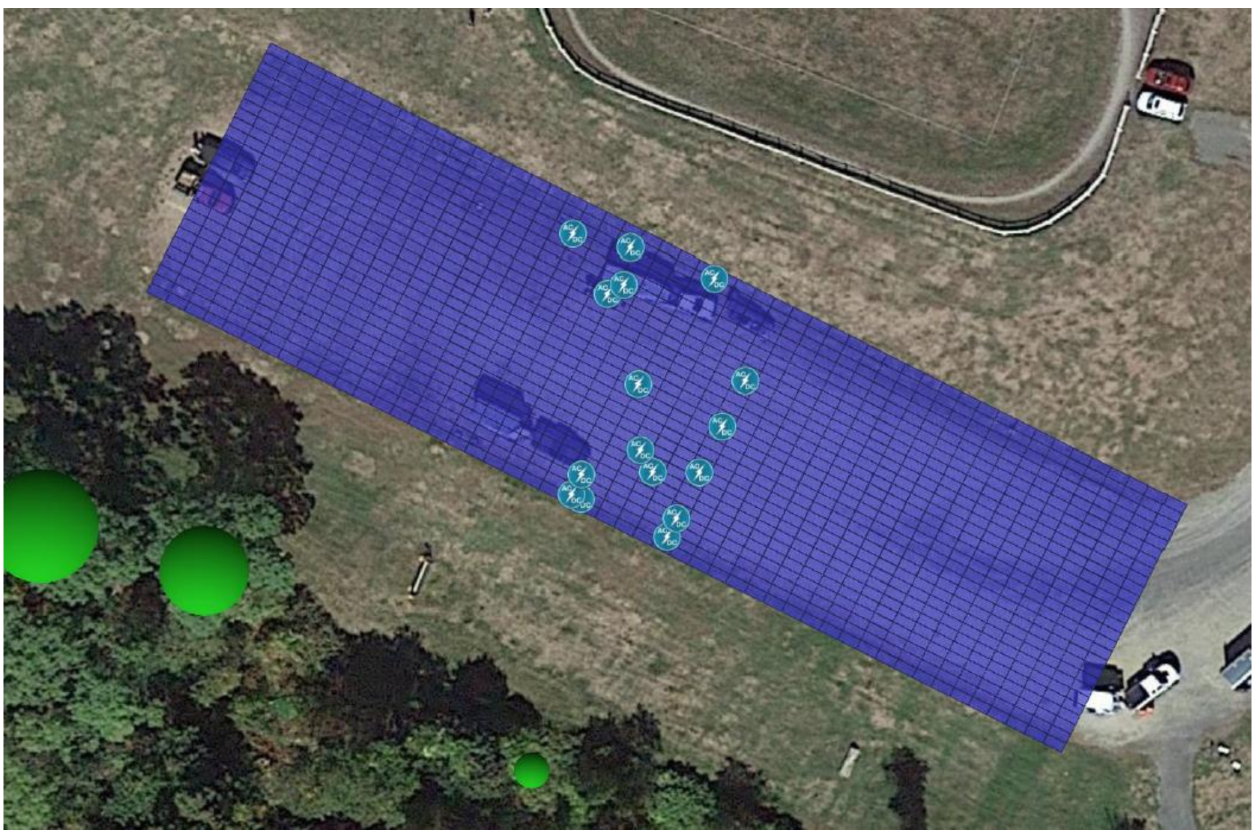


Figure 13: Location 1.5 Panel Layout – Canopy Parking.

Table 25: Location 1.5 Monthly Energy Generation – Canopy Parking.

1.5 Pipestave Recreation - Parking Canopy	
Month	Predicted Solar PV Generation
January	37,498
February	48,894
March	72,692
April	78,681
May	88,308
June	86,928
July	94,969
August	82,711
September	68,935
October	50,484
November	35,827
December	28,778
Total	**774,705**

Economic Screening

The high level opinions of probable cost and incentives and the preliminary life cycle cost analysis for the system(s) considered at this location are summarized in the table below.

Table 26: Location 1.5 Preliminary Economic Summary.

Mounting	Estimated SMART Incentive Rate	Estimated Direct Ownership Economics				Estimated PPA	
		Order of Magnitude Construction Cost Estimate	Estimated Year 1 Net Cash Flow	Estimated 20-Year Net Present Value	Estimated Discounted Payback Period	Estimated Year 1 Net Cash Flow	Estimated 20-Year Net Present Value
-	$/kWh	$	$	$	year	$	$
Rooftop	-	$129,500	$18,119	$124,219	5	$13,584	$160,767
Ground	$0.013	$86,400	$16,905	$139,765	3	$12,897	$153,005
Parking Canopy	-	$4,165,000	$315,880	$833,494	13	$144,054	$1,654,214

The potential SMART incentive rates were estimated based on the following information gathered from the "2023 SMART-BTM-Value-of-Energy-Workbook":

<u>Rooftop System:</u>

- G-1 Rate Class, Net-Metered Value of Energy = $0.21144
- Greater than 25 kW AC to 250 kW AC, Block 10 Base Compensation Rate = $0.16847/kWh
- Building Mounted Solar Tariff Generation Unit, Compensation Rate Adder = $0.0192/kWh

- Base Compensation Rate + Compensation Rate Adder – Value of Energy = **Estimated SMART Incentive = $0.00/kWh**

Ground-Mount System:

- G-1 Rate Class, Net-Metered Value of Energy = $0.21144
- Less than or equal to 25 kW AC, Block 10 Base Compensation Rate = $0.22463/kWh
- No Compensation Rate Adders
- Base Compensation Rate + Compensation Rate Adder – Value of Energy = **Estimated SMART Incentive = $0.013/kWh**

Canopy Carport System:

The SMART program offers an Alternative On-Bill Credit for systems interconnected as standalone systems, not serving on-site loads behind-the-meter. Based on information published on the DOER's website, Alternative On-Bill Credits are only available for systems that are unable to receive net metering credits. This screening study assumes that net metering will be available, and therefore assumes that SMART program incentives will not be offered for any standalone systems.

1.6 Page School

Existing Conditions

The Dr. John C Page School, also known as the Page School, is an elementary school located on Parcel R23-23, which is owned by the Town of West Newbury. The 120+ acre parcel is considered to be a high conservation priority area by the Town and is adjacent to the Riverbend Conservation Area, which is on Parcel R25-17 and R25-20.

Table 27: Location 1.6 existing electric service.

1.6 Page School					
Electric Utility			Main Electric Service		
Account #	Meter #	Rate	Amps	Voltage	Phase
35062-33006	25140352	G2	4000	120/208	3

The Page School's existing electrical service is provided via a National Grid 13.2 kV grid-Y /7.62 kV primary – 208 V Y / 120 V secondary service, pad mount utility transformer located in front of the building. The building's main service entry gear is located at ground level in an electric room. The existing service entrance switchboard is 4000A, 3 phase, 4 wire, 208Y/120VAC. The existing main distribution panel has two 400A spare positions, as well as several blank positions.

The LGSPI map provided by West Newbury indicates the National Grid primary feeder in the immediate vicinity of the building along Main Street may have sufficient 3-phase capacity to host a solar PV installation.

The Main Street Solar Project is located on the same property as the Page School but is not associated with nor interconnected with the school. The solar PV system is a ground-mount system owned and operated by a 3rd party. Electricity generated by the system is used by other municipal buildings via virtual net metering.

The graph below shows the building's historical monthly electricity use. Monthly electricity use is relatively consistent each month, which the exception of 2020. Lower usage in 2020 is likely attributed to reduced occupancy from the COVID-19 pandemic.

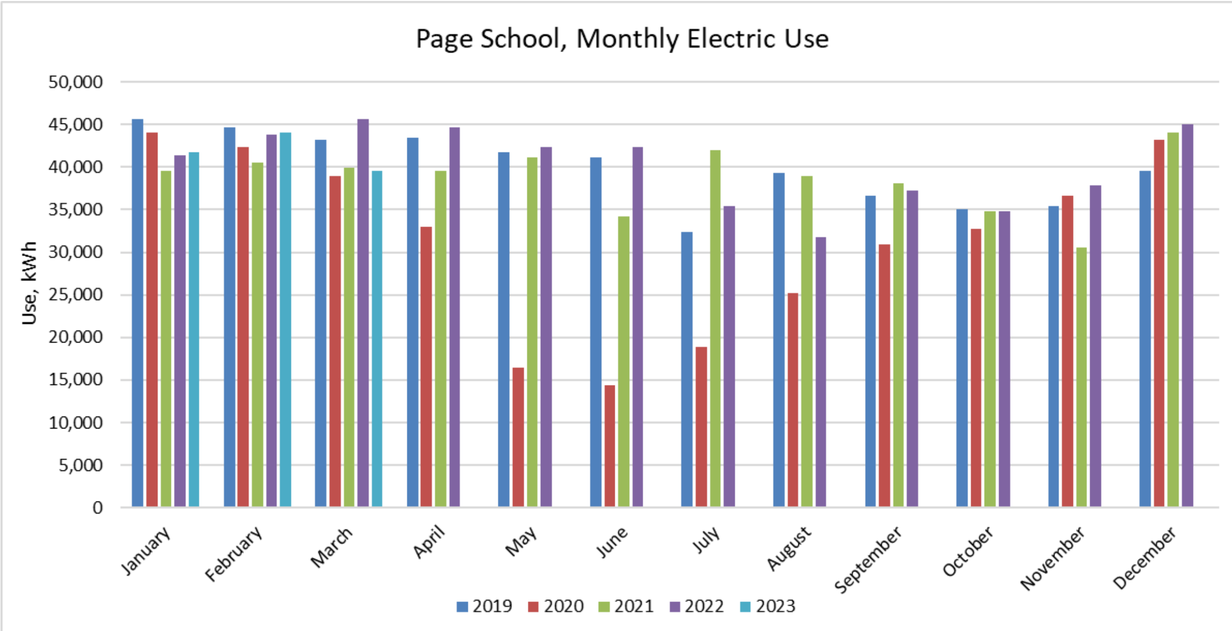


Figure 14: Location 1.6 monthly electricity use.

Solar PV Review

Technical Screening

A ground-mount solar PV system in the open land behind the school was considered in this screening study. Rooftop solar PV and canopy parking lot solar PV were not considered in this primarily due to town preferences.

The preliminary screening results, including AC nameplate power, monthly and annual electricity generation, and panel layouts, for the ground-mount solar PV system are shown in the tables and figure below. The ground-mount systems were modeled at a 30° tilt angle and an azimuth angle of 180°, which is south-facing.

Table 28: Location 1.6 Solar PV Screening Summary.

1.6 Page School			
Location	Mounting	Preliminary Inverter AC Nameplate kW	Estimated Annual Energy Generation kWh
Open Space	Ground	450	772,453

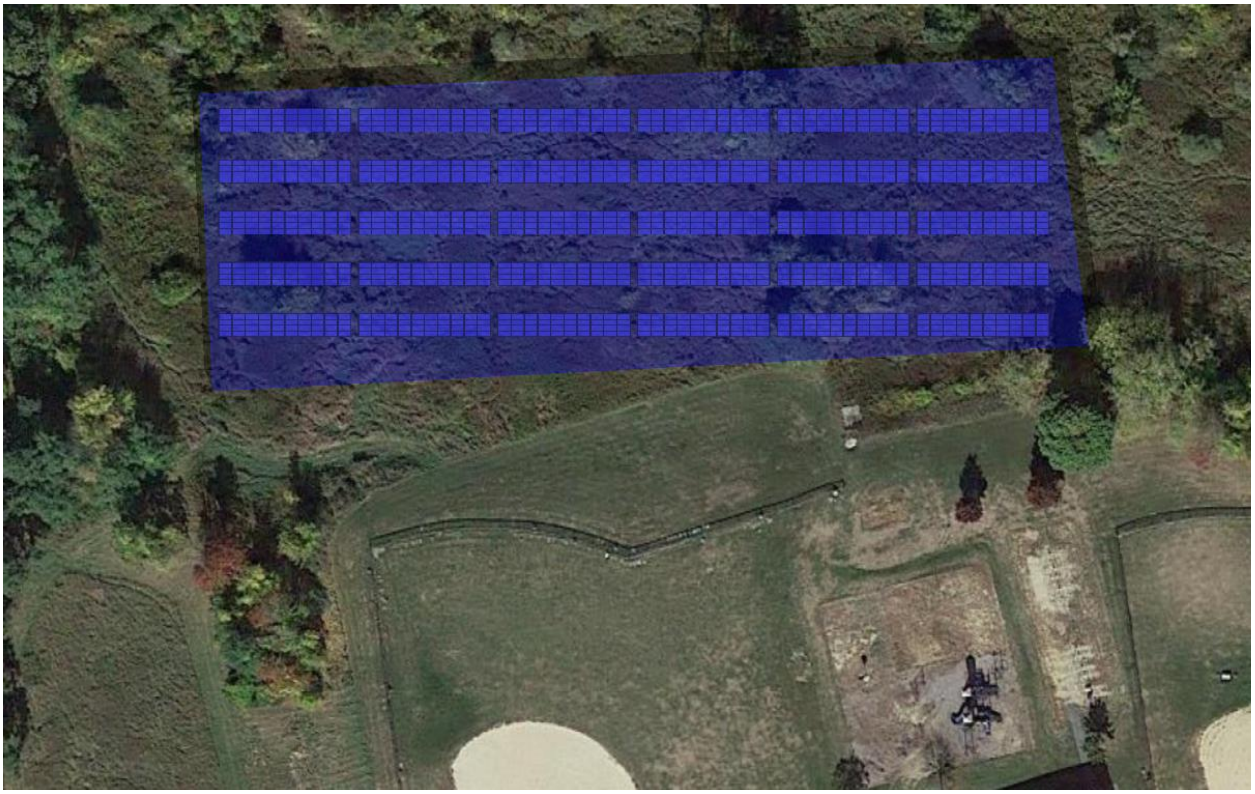


Figure 15: Location 1.6 Panel Layout – Ground-Mount.

Table 29: Location 1.6 Monthly Energy Generation – Ground-Mount.

1.6 Page School - Ground	
Month	Predicted Solar PV Generation
January	48,071
February	57,777
March	75,850
April	73,475
May	77,468
June	74,015
July	82,506
August	76,178
September	69,846
October	57,547
November	43,675
December	36,045
Total	**772,453**

Economic Screening

The high level opinions of probable cost and incentives and the preliminary life cycle cost analysis for the system(s) considered at this location are summarized in the table below.

Table 30: Location 1.6 Preliminary Economic Summary.

Mounting	Estimated SMART Incentive Rate	Estimated Direct Ownership Economics				Estimated PPA	
		Order of Magnitude Construction Cost Estimate	Estimated Year 1 Net Cash Flow	Estimated 20-Year Net Present Value	Estimated Discounted Payback Period	Estimated Year 1 Net Cash Flow	Estimated 20-Year Net Present Value
-	$/kWh	$	$	$	year	$	$
Ground	-	$1,620,000	$203,578	$1,272,290	6	$135,295	$1,590,771

The potential SMART incentive rate was estimated based on the following information gathered from the “2023 SMART-BTM-Value-of-Energy-Workbook”:

<u>Ground-Mount System:</u>

- G-2 NEMA Rate Class, Net-Metered Value of Energy = $0.17173
- Greater than 25 kW AC to 250 kW AC, Block 10 Base Compensation Rate = $0.16847/kWh
- No Compensation Rate Adders
- Base Compensation Rate + Compensation Rate Adder – Value of Energy = **Estimated SMART Incentive = $0.00/kWh**

1.7 Dunn Property

Existing Conditions

The Dunn Property, consisting of the North, Central, and South Dunn Fields, is located on Parcel R26-19, which is owned by the Town of West Newbury. The 70+ acre parcel is considered to be a high conservation priority area by the Town.

There are not any existing local electrical services or loads located at the fields.

The LGSPI map provided by West Newbury indicates the National Grid primary feeder in the immediate vicinity of the property along Chase Street does not have any 3-phase service or capacity. Based on measurement estimates acquired from Google Earth, the North Dunn Field appears to be within the 1000-foot boundary of 3-phase utility infrastructure on Main Street. However, the South Dunn Field is outside of the 1000-foot boundary. Further review would be required to determine if solar PV systems at the Dunn Property could be interconnected to existing utility infrastructure on Main Street, or the scope of potential utility infrastructure upgrades on Chase Street to upgrade to 3-phase power.

Solar PV Review

Technical Screening

Ground-mount solar PV systems in the open land in the North and South Dunn Fields were considered in this screening study.

The preliminary screening results, including AC nameplate power, monthly and annual electricity generation, and panel layouts, for the ground-mount solar PV systems are shown in the tables and figures below. The ground-mount systems were modeled at a 30° tilt angle and an azimuth angle of 180°, which is south-facing.

Table 31: Location 1.7 Solar PV Screening Summary.

1.7 Dunn Property			
Location	Mounting	Preliminary Inverter AC Nameplate kW	Estimated Annual Energy Generation kWh
North Field	Ground	300	480,886
South Field	Ground	938	1,505,731

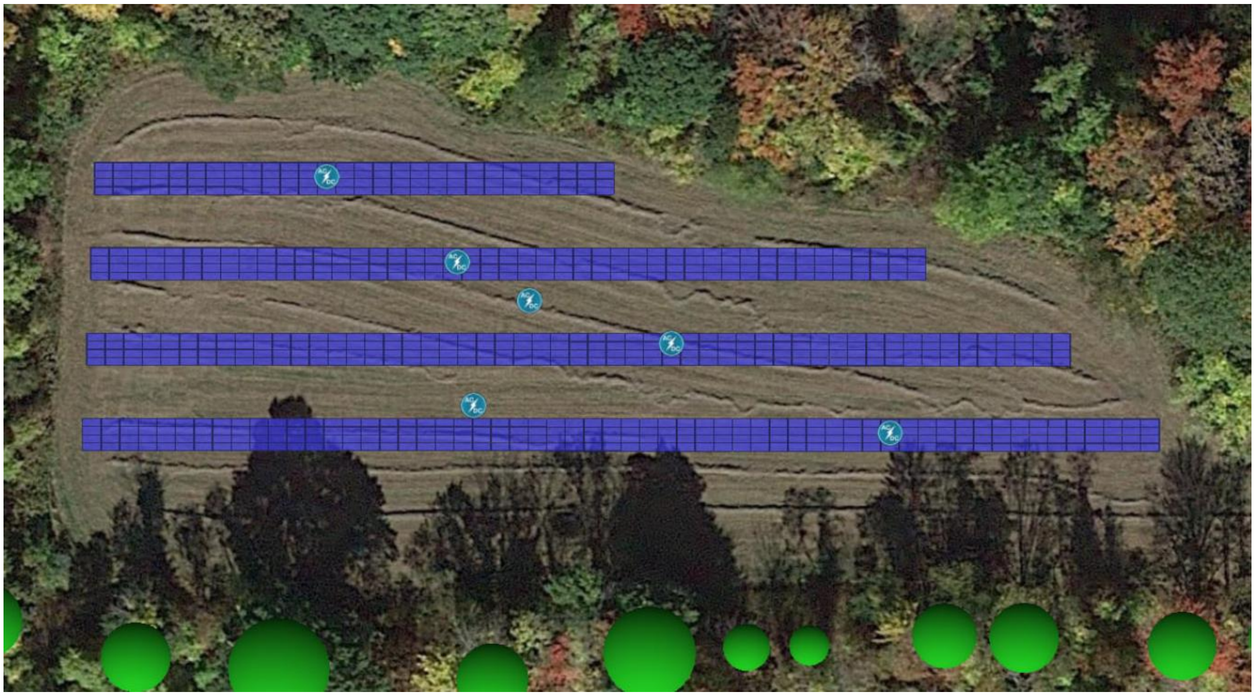


Figure 16: Location 1.7 Panel Layout – North Field.

Table 32: Location 1.7 Monthly Energy Generation – North Field.

1.7 Dunn Property - North Field	
Month	Predicted Solar PV Generation
January	30,813
February	35,831
March	47,279
April	45,883
May	47,998
June	45,638
July	50,836
August	46,946
September	43,031
October	35,489
November	27,374
December	23,768
Total	**480,886**

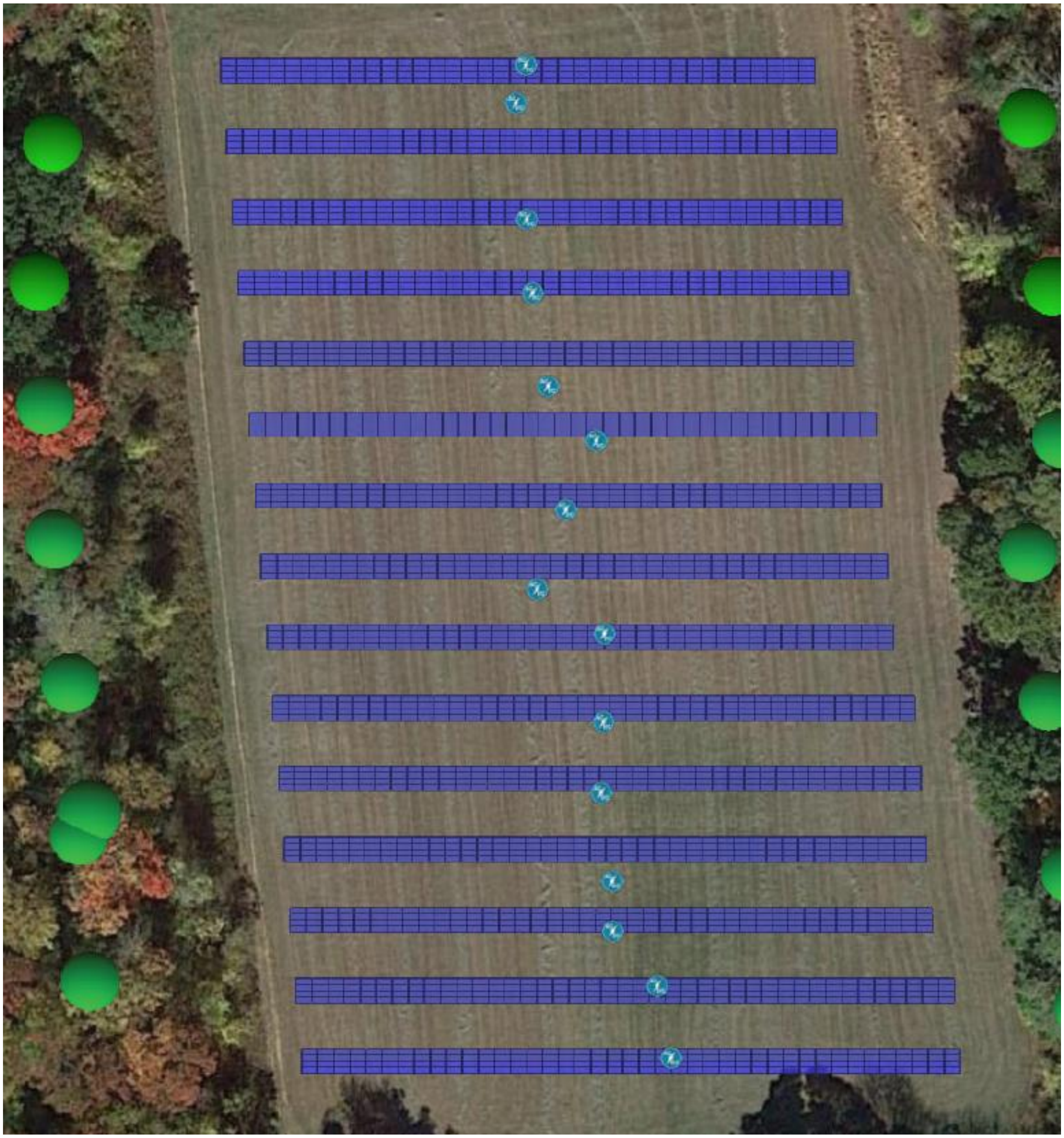


Figure 17: Location 1.7 Panel Layout – South Field.

Table 33: Location 1.7 Monthly Energy Generation – South Field.

1.7 Dunn Property - South Field	
Month	Predicted Solar PV Generation
January	100,805
February	118,664
March	151,585
April	141,379
May	143,883
June	134,861
July	151,436
August	143,618
September	136,599
October	116,864
November	90,556
December	75,481
Total	**1,505,731**

ECONOMIC SCREENING

The high level opinions of probable cost and incentives and the preliminary life cycle cost analysis for the system(s) considered at this location are summarized in the table below.

Table 34: Location 1.7 Preliminary Economic Summary.

Mounting	Estimated SMART Incentive Rate	Estimated Direct Ownership Economics				Estimated PPA	
		Order of Magnitude Construction Cost Estimate	Estimated Year 1 Net Cash Flow	Estimated 20-Year Net Present Value	Estimated Discounted Payback Period	Estimated Year 1 Net Cash Flow	Estimated 20-Year Net Present Value
-	$/kWh	$	$	$	year	$	$
Ground	-	$993,000	$196,768	$1,642,714	3	$154,166	$1,828,675
Ground	-	$3,300,000	$614,967	$4,992,348	3	$482,718	$5,725,875

The SMART program offers an Alternative On-Bill Credit for systems interconnected as standalone systems, not serving on-site loads behind-the-meter. Based on information published on the DOER's website, Alternative On-Bill Credits are only available for systems that are unable to receive net metering credits. This screening study assumes that net metering will be available, and therefore assumes that SMART program incentives will not be offered for any standalone systems.

OTHER SCREENING FACTORS

SOLAR TRACKING SYSTEMS

The purpose of solar tracking systems is to change the position of the solar panels based on the position of the sun to maximize output. Solar tracking systems are most commonly seen on ground-mounted solar PV systems, rather than rooftop or carport, due to the increased size and weight. Manual tracking systems need to be manually adjusted by the owner's personnel, which could be done seasonally. Active tracking systems automatically change position based on the position of the sun using motors or hydraulic systems. There are generally two types of solar tracking systems: single-axis and dual-axis. Single-axis tracking systems move from east to west, while dual-axis systems also move from north to south. Solar tracking systems can increase output in the range of 20-40%. However, including a solar tracking system will increase not only the upfront installation costs, but also the annual operations and maintenance cost. The SMART program offers a compensation rate adder of $0.01/kWh for eligible solar PV systems with solar trackers.

The list below summarizes the locations where ground-mount systems were screened, which could be potentially paired with a solar tracking system:

- 1.1 Housing Authority
- 1.5 DPW Garage
- 1.6 Page School
- 1.7 Dunn Property, North and South Dunn Fields

It is recommended to complete further design and cost-benefit analysis in the next phase of study, if West Newbury is interested in exploring solar tracking systems at these locations further.

COMMUNITY SOLAR

Installing a community solar project in West Newbury would create the opportunity for local residents and business owners to share the benefits of solar power. Community solar projects are generally large-scale PV systems, in the range of 0.5 MW up to 20 MW. Community solar programs in Massachusetts typically utilize the virtual net metering bill crediting system. On average, most National Grid community solar subscribers in Massachusetts can save 5-10% on their annual electricity costs[2]. If the installer is pursuing incentives from the SMART program, they could be eligible for up to a $0.03064/kWh compensation rate adder for community shared solar projects.

The list below suggests two locations screened in this study, which the Town may want to consider discussing potential community solar eligibility with National Grid during future phases of study and design. These locations are larger-scale PV systems with no local loads to serve, so they may be viable candidates for community solar projects.

- 1.5 Pipestave Recreation, Parking Lot

[2] https://www.energysage.com/local-data/community-solar/ma/national-grid/

- 1.7 Dunn Property, South Dunn Field

BATTERY ENERGY STORAGE SYSTEMS

Battery energy storage system (BESS) is an electrochemical energy storage device that allows energy to be stored for extended durations and be released as needed or directed by the owner. The BESS is bi-directional, allowing it to be charged as a load on the electric system and discharged as a source of electric energy. The BESS can be charged by the utility grid, or via any combination of on-site distributed energy resources (DERs), such as solar PV systems. The BESS stores this charged energy until it is needed, then releases it onto the electrical distribution system as required. The most common electrochemical technology used today is lithium-ion batteries. Other types of electrochemical energy storage include lead acid, sodium sulfur, sodium nickel chloride, and flow batteries. A technical datasheet for an example lithium-ion BESS is attached in Appendix B. This example battery is rated for 125 kW and 2, 4, or 6 hours of storage.

The BESS can be used for several applications, including demand response, peak shaving, off-grid resiliency, and frequency regulation. Customers can enroll their BESS in demand response programs, such as National Grid's Connected Solutions Daily Dispatch program, which offers incentives of $200 per average kW reduction each season. The Daily Dispatch season is June through September, with most events occurring in July and August. There are typically 30 to 60 events per year, each lasting 2-3 hours.

Customers can also utilize their BESS as a power source, when grid power is unavailable, to power standby loads in a building. Common commercial-scale battery storage duration times typically range from 1-6 hours, depending on the customers energy resilience goals. Further, the BESS would provide a reference voltage during a grid outage, which would allow any co-located solar PV systems to generate electricity to power the standby loads or to recharge the battery, while sunlight is available.

Battery energy storage systems could be procured directly by the Town or through a PPA by a 3rd party provider. Batteries may be eligible for the federal ITC, either as a standalone asset or when paired with solar PV, based on available information published online by the US Department of Energy. Further, pairing a BESS with a solar PV system could increase the potential SMART incentive rate through the energy storage compensation adder.

The list below summarizes the locations where behind-the-meter solar PV systems were considered, which could potentially be paired with a BESS:

- 1.1 Housing Authority
    - During the walkthrough, the Town mentioned that Housing Authority stakeholders are interested in implementing off-grid capable DERs to maintain safe, comfortable conditions for residents during extended grid power outages. The Town may want to further consider a BESS at this location during future phases of study and design.
- 1.2 1910 Building
- 1.3 Public Safety Complex

    - The Town may be interested in further improving the energy resiliency of the Public Safety Complex, home to both the police and fire station. There is an existing on-site diesel generator to provide standby power during a grid outage event, but the Town may want to further consider adding a BESS at this location during future phases of study and design.
- 1.5 DPW Garage
- 1.6 Page School

As a next step, we recommend that the Town discuss their energy resilience goals amongst its stakeholders to determine the level of interest in considering battery energy storage at one, or more, of the sites listed above.

RESILIENCY

Solar PV systems are not energy resilient as a standalone asset, and therefore cannot generate electricity if grid power is not available, if it is in the only on-site DER. Solar PV systems require a reference voltage from another source, such as the utility grid or an on-site BESS. If a solar PV system is co-located with a BESS, then the solar PV system could generate electricity to power building loads or to charge the battery, while sunlight is available. The list in the section includes locations which may be favorable for solar PV systems paired with a BESS, as discussed above.

Sites which may have multiple DERs, such as solar PV, BESS, wind, and/or fossil fuel generators, could explore integrating all these assets together to operate as a microgrid. Additional programming and controls, including a system supervisory controller, also known as a microgrid controller, would be required to control each of the assets during both normal, grid-tied mode and resilient, off-gird mode. During normal operations, the solar PV could generate electricity to power building loads, the BESS could discharge to reduce the building's peak demand or participate in demand response events, and the generator would be off. During off-grid operations, the solar PV could generate electricity during the day to meet standby building loads, while the battery either discharges and "trims" to meet the remaining loads, or charges from excess solar PV generation. At night, when the solar PV is unavailable, the battery could discharge to meet standby loads, until it reaches a predetermined minimum state of charge, then the generator could run, as needed. Adding solar PV and battery energy storage to a building that has an existing standby generator could allow the customer to not only reduce their dependence on fuel deliveries during a potential emergency, but also meet their building loads with renewable electricity, instead of fossil fuels.

Some microgrids are configured to serve one building, while others are tied to several buildings. The Town has been exploring the feasibility of implementing a community microgrid at the "Municipal Campus," which includes the 1910 Building, the Annex, the Housing Authority, and the Public Safety Complex (Locations 1.1, 1.2, and 1.3), which was studied in feasibility study completed by another consultant in 2018. If the Town is interested in pursing a community microgrid further, we recommend commencing a more detailed feasibility study to explore how the solar PV systems screened in this study could be paired with existing, or new, diesel generators and new battery energy storage systems to provide resilient power to the Municipal Campus during grid-outage events.

APPENDIX A: HELIOSCOPE REPORTS

Appendix B: Sample Battery Energy Storage System Cut Sheet

APPENDIX A: HELIOSCOPE REPORTS

1.1 Housing Authority Ground West Newbury 381 Main St, West Newbury, MA 01985, USA

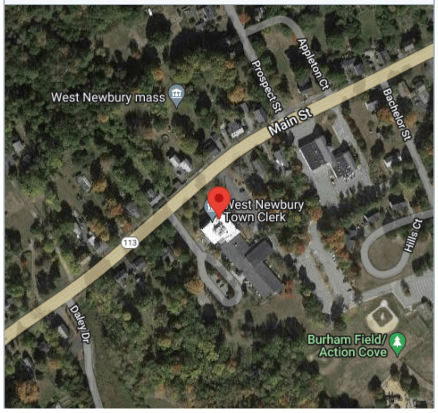
Project Details

Address	381 Main St, West Newbury, MA 01985, USA
Owner	Gabrielle Cole
Last Modified	Gabrielle Cole a minute ago
Location	(42.80050330000001, -70.9892665) (GMT -5)
Profile	Default Commercial

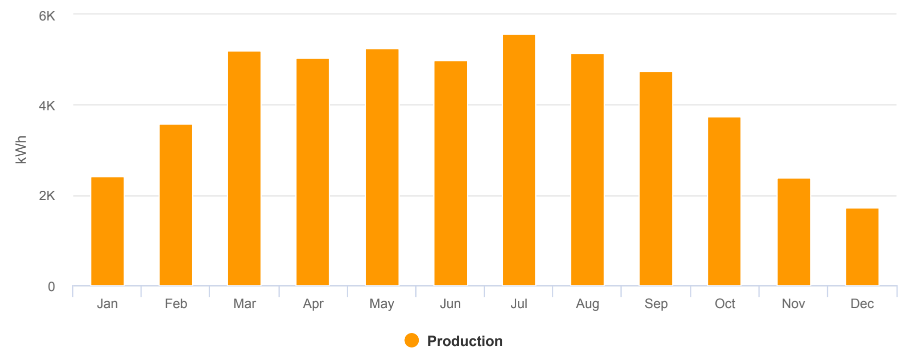
System Metrics

Design	1.1 Housing Authority Ground
Module DC Nameplate	36.9 kW
Inverter AC Nameplate	33.3 kW Load Ratio: 1.11
Annual Production	49.8 MWh
Performance Ratio	79.2%
kWh/kWp	1,350.6
Weather Dataset	TMY, 10km grid (42.85,-70.95), NREL (prospector)
Simulator Version	670ad8e266-60b9f88dc3-7fd752c342-6de52fe339

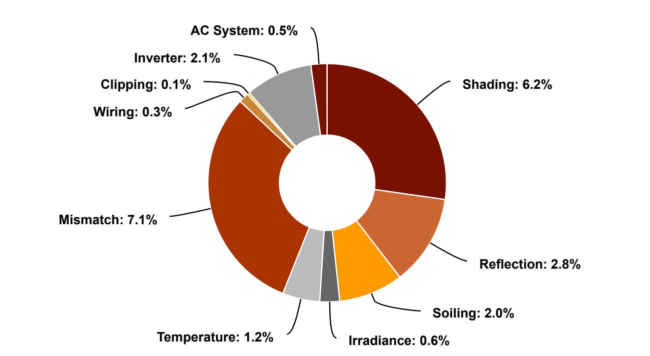
Project Location



Production



System Loss



Annual Production

	Description	Output	% Delta
Irradiance (kWh/m^2)	Annual Global Horizontal Irradiance	1,427.4	-
	POA Irradiance	1,704.7	19.4%
	Shaded Irradiance	1,598.7	-6.2%
	Irradiance After Reflection	1,553.8	-2.8%
	Irradiance After Soiling	1,522.7	-2.0%
	Total Collector Irradiance	**1,522.6**	**-0.0%**
Energy (kWh)	Nameplate	56,241.0	-
	Output at Irradiance Levels	55,897.3	-0.6%
	Output at Cell Temperature Derate	55,249.7	-1.2%
	Output After Mismatch	51,352.1	-7.1%
	Optimal DC Output	51,191.1	-0.3%
	Constrained DC Output	51,153.9	-0.1%
	Inverter Output	50,087.6	-2.1%
	Energy to Grid	**49,837.1**	**-0.5%**
Temperature Metrics			
	Avg. Operating Ambient Temp	11.9°C	
	Avg. Operating Cell Temp	20.0°C	
Simulation Metrics			
	Operating Hours	4,669	
	Solved Hours	4,669	
	Pending Hours	-	
	Error Hours	-	

Condition Set

Description	Condition Set 1
Weather Dataset	TMY10km grid (42.85,-70.95)NREL(prospector) (download)
Solar Angle Location	Meteo Lat/Lng
Transposition Model	Perez Model
Temperature Model	Sandia Model
Irradiation Variance	5.0%
Cell Temperature Spread	4.0°C
Module Binning Range	-2.5% to 2.5%
AC System Derate	0.50%

Temperature Model Parameters

Rack Type	a	b	Temperature Delta
Fixed Tilt	-3.56	-0.08	3.0°C
Flush Mount	-2.81	-0.05	0.0°C
East-West	-3.56	-0.08	3.0°C
Carport	-3.56	-0.08	3.0°C

Soiling (%)

J	F	M	A	M	J	J	A	S	O	N	D
2	2	2	2	2	2	2	2	2	2	2	2

Component Characterizations

Type	Component	Characterization
Module	LG450S2W-U6 (1000V) (LG)	Spec Sheet Characterization,PAN
Inverter	Sunny Tripower_Core1 33-US-41 (SMA)	Default Characterization

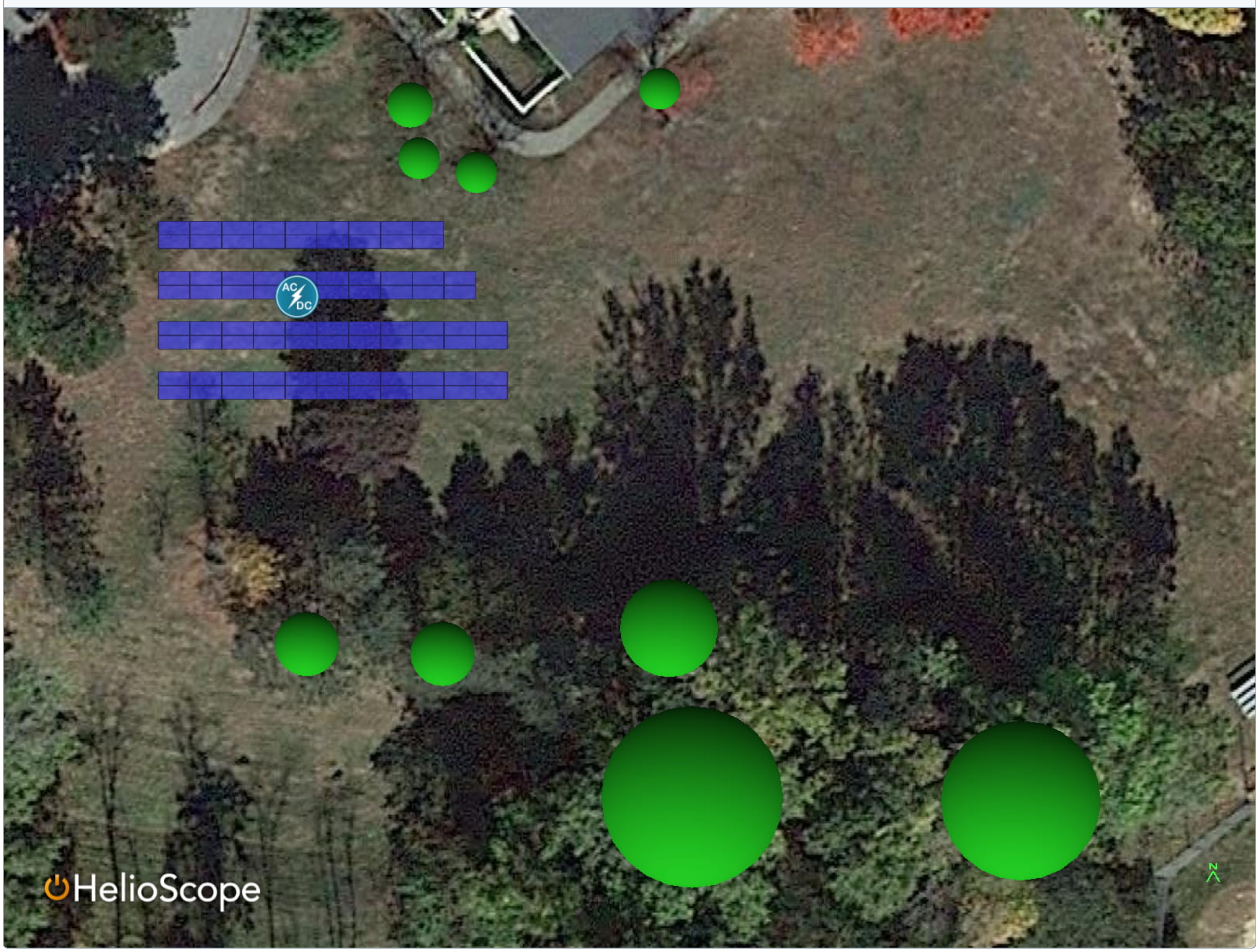
Design BOM

Component	Type	Quantity
2 input Combiners	Combiners	1
3 input Combiners	Combiners	1
12 AWG (Copper)	Home Runs	2
Sunny Tripower_Core1 33-US-41	Inverters	1
LG450S2W-U6 (1000V)	Modules	82
10 AWG (Copper)	Strings	5

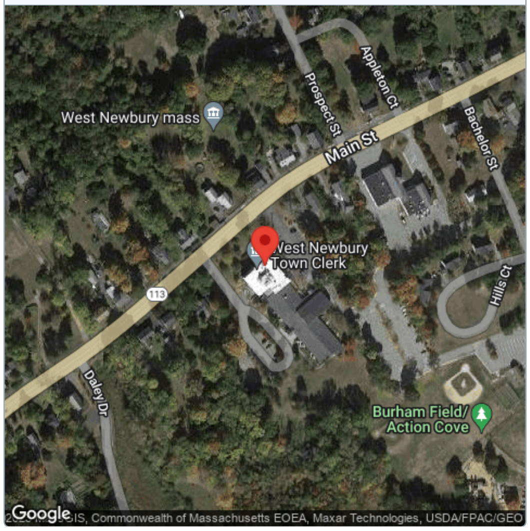
Monthly Shading

Month	GHI (kWh/m^2)	POA (kWh/m^2)	Shaded (kWh/m^2)	Nameplate (kWh)	Grid (kWh)
January	60.4	105.1	86.5	3,042.2	2,420.2
February	81.1	119.6	110.2	3,879.0	3,572.2
March	125.9	160.6	155.6	5,479.1	5,200.6
April	146.3	161.4	155.9	5,488.4	5,042.6
May	169.5	172.3	165.6	5,820.5	5,262.5
June	171.2	167.5	160.4	5,624.8	4,993.9
July	188.3	188.2	181.2	6,367.3	5,584.4
August	160.2	172.7	166.6	5,862.4	5,163.4
September	128.4	155.6	150.8	5,311.2	4,741.9
October	89.4	125.1	118.7	4,183.6	3,745.1
November	60.3	94.8	82.0	2,885.6	2,388.1
December	46.4	81.9	65.3	2,296.8	1,722.3

Design Render



Project Location



Design Wiring Zone

Description	Combiner Poles	String Size	Stringing Strategy
Wiring Zone	12	4 - 17	Along Racking

Field Segments

Description	Racking	Orientation	Tilt	Azimuth	Intrarow Spacing	Frame Size	Frames	Modules	Power
Field Segment 1	Fixed Tilt	Landscape (Horizontal)	30°	180°	5.0 ft	2x1	41	82	36.90 kW

1.1 Housing Authority Rooftop West Newbury 381 Main St, West Newbury, MA 01985, USA

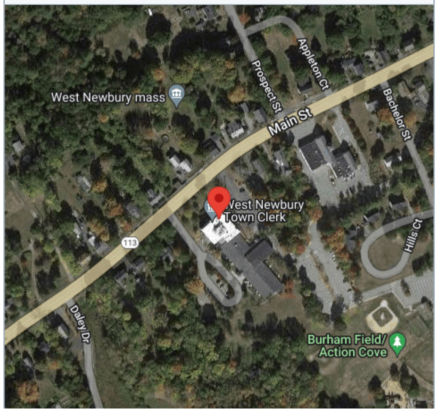
Project Details

Address	381 Main St, West Newbury, MA 01985, USA
Owner	Gabrielle Cole
Last Modified	Gabrielle Cole a few seconds ago
Location	(42.80050330000001, -70.9892665) (GMT -5)
Profile	Default Commercial

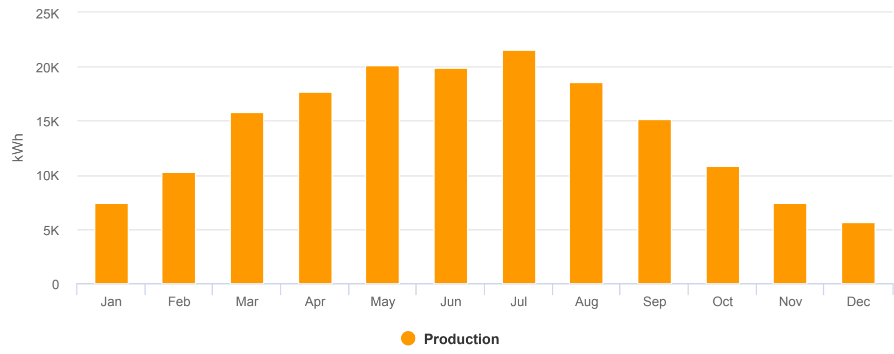
System Metrics

Design	1.1 Housing Authority Rooftop
Module DC Nameplate	146.7 kW
Inverter AC Nameplate	133.2 kW Load Ratio: 1.10
Annual Production	170.4 MWh
Performance Ratio	80.6%
kWh/kWp	1,161.6
Weather Dataset	TMY, 10km grid (42.85,-70.95), NREL (prospector)
Simulator Version	e0419dc019-dcabad097e-4d5d0f02fa-0e176ffd8f

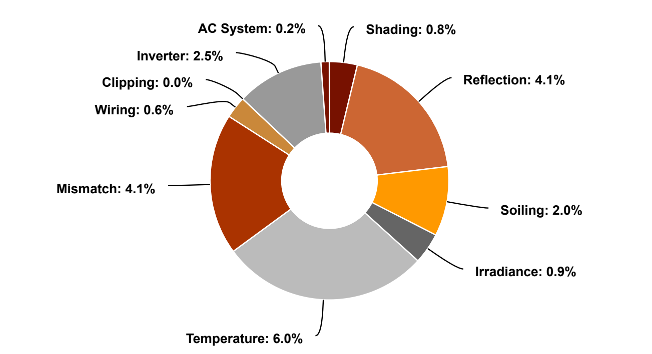
Project Location



Production



System Loss



Annual Production

	Description	Output	% Delta
Irradiance (kWh/m^2)	Annual Global Horizontal Irradiance	1,427.4	-
	POA Irradiance	1,440.4	0.9%
	Shaded Irradiance	1,429.0	-0.8%
	Irradiance After Reflection	1,370.4	-4.1%
	Irradiance After Soiling	1,343.0	-2.0%
	Total Collector Irradiance	**1,343.0**	**0.0%**
Energy (kWh)	Nameplate	197,209.7	-
	Output at Irradiance Levels	195,456.6	-0.9%
	Output at Cell Temperature Derate	183,778.0	-6.0%
	Output After Mismatch	176,302.5	-4.1%
	Optimal DC Output	175,193.7	-0.6%
	Constrained DC Output	175,191.7	-0.0%
	Inverter Output	170,812.0	-2.5%
	Energy to Grid	**170,400.0**	**-0.2%**

Temperature Metrics

Avg. Operating Ambient Temp	11.9°C
Avg. Operating Cell Temp	26.6°C

Simulation Metrics

Operating Hours	4,669
Solved Hours	4,669
Pending Hours	-
Error Hours	-

Condition Set

Description	Condition Set 1
Weather Dataset	TMY10km grid (42.85,-70.95)NREL(prospector) (download)
Solar Angle Location	Meteo Lat/Lng
Transposition Model	Perez Model
Temperature Model	Sandia Model

Temperature Model Parameters

Rack Type	a	b	Temperature Delta
Fixed Tilt	-3.56	-0.08	3.0°C
Flush Mount	-2.81	-0.05	0.0°C
East-West	-3.56	-0.08	3.0°C
Carport	-3.56	-0.08	3.0°C

Soiling (%)

J	F	M	A	M	J	J	A	S	O	N	D
2	2	2	2	2	2	2	2	2	2	2	2

Irradiation Variance	5.0%
Cell Temperature Spread	4.0°C
Module Binning Range	-2.5% to 2.5%
AC System Derate	0.50%

Component Characterizations

Type	Component	Characterization
Module	LG450S2W-U6 (1000V) (LG)	Spec Sheet Characterization,PAN
Module	LG450S2W-U6 (1000V) (LG)	Spec Sheet Characterization,PAN
Inverter	Sunny Tripower CORE1 33-US (SMA)	Spec Sheet

Design BOM

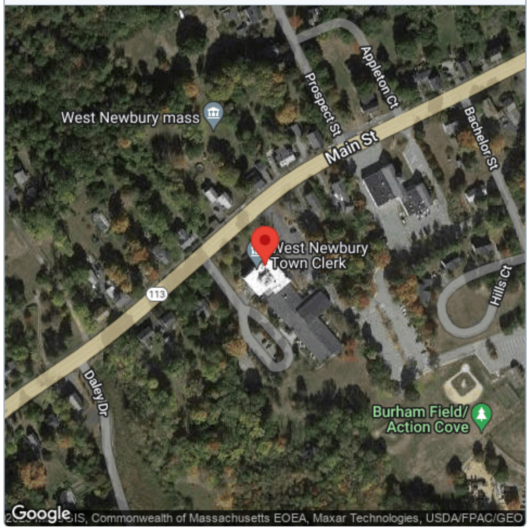
Component	Type	Quantity
1/0 AWG (Aluminum)	AC Home Runs	4
2 input Combiners	Combiners	4
3 input Combiners	Combiners	4
12 AWG (Copper)	Home Runs	8
Sunny Tripower CORE1 33-US	Inverters	4
LG450S2W-U6 (1000V)	Modules	326
10 AWG (Copper)	Strings	20

Monthly Shading

Month	GHI (kWh/m^2)	POA (kWh/m^2)	Shaded (kWh/m^2)	Nameplate (kWh)	Grid (kWh)
January	60.4	61.9	60.4	8,070.1	7,428.0
February	81.1	82.6	81.5	11,078.0	10,283.3
March	125.9	127.4	126.6	17,418.7	15,859.5
April	146.3	147.0	146.2	20,304.5	17,741.5
May	169.5	170.0	169.2	23,570.4	20,116.2
June	171.2	171.6	170.7	23,770.5	19,895.4
July	188.3	188.8	187.9	26,199.0	21,535.0
August	160.2	161.1	160.3	22,289.1	18,539.7
September	128.4	129.7	129.0	17,819.9	15,150.6
October	89.4	90.8	89.9	12,288.1	10,798.3
November	60.3	61.7	60.7	8,195.4	7,387.3
December	46.4	47.7	46.5	6,206.0	5,665.2

Design Render

Project Location



Design Wiring Zone

Description	Combiner Poles	String Size	Stringing Strategy
Wiring Zone	12	9 - 17	Along Racking

Field Segments

Description	Racking	Orientation	Tilt	Azimuth	Intrarow Spacing	Frame Size	Frames	Modules	Power
Field Segment 1	Flush Mount	Portrait (Vertical)	5°	228.892°	0.0 ft	1x1	214	214	96.30 kW
Field Segment 2	Flush Mount	Portrait (Vertical)	5°	48.895°	0.0 ft	1x1	112	112	50.40 kW

1.2 1910 Building Parking Lot West Newbury 381 Main St, West Newbury, MA 01985, USA

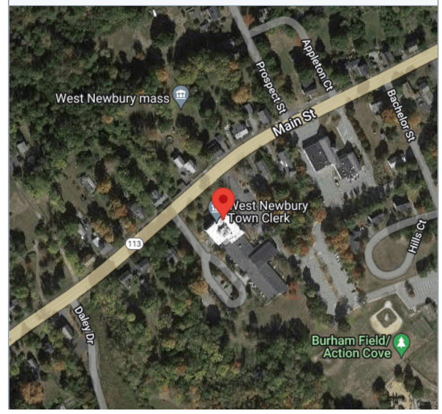
Project Details

Address	381 Main St, West Newbury, MA 01985, USA
Owner	Gabrielle Cole
Last Modified	Gabrielle Cole a few seconds ago
Location	(42.80050330000001, -70.9892665) (GMT -5)
Profile	Default Commercial

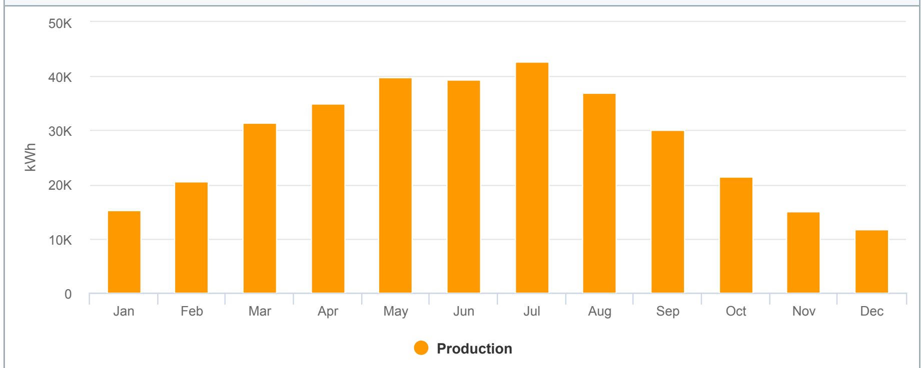
System Metrics

Design	1.2 1910 Building Parking Lot
Module DC Nameplate	270.0 kW
Inverter AC Nameplate	240.0 kW Load Ratio: 1.13
Annual Production	339.6 MWh
Performance Ratio	85.8%
kWh/kWp	1,257.8
Weather Dataset	TMY, 10km grid (42.85,-70.95), NREL (prospector)
Simulator Version	e0419dc019-dcabad097e-4d5d0f02fa-0e176ffd8f

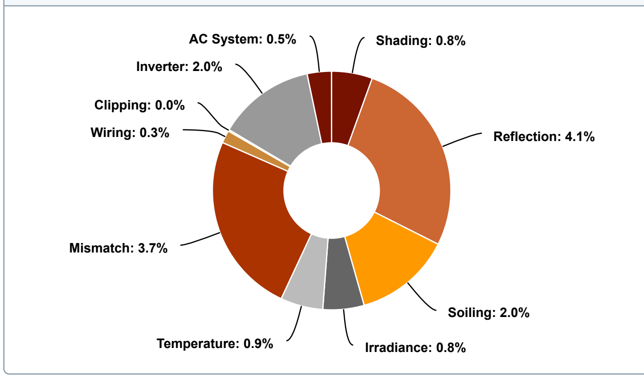
Project Location



Production



System Loss



Annual Production

	Description	Output	% Delta
Irradiance (kWh/m^2)	Annual Global Horizontal Irradiance	1,427.4	-
	POA Irradiance	1,465.7	2.7%
	Shaded Irradiance	1,453.4	-0.8%
	Irradiance After Reflection	1,394.0	-4.1%
	Irradiance After Soiling	1,366.2	-2.0%
	Total Collector Irradiance	**1,366.1**	**-0.0%**
Energy (kWh)	Nameplate	369,202.0	-
	Output at Irradiance Levels	366,072.8	-0.8%
	Output at Cell Temperature Derate	362,871.9	-0.9%
	Output After Mismatch	349,304.0	-3.7%
	Optimal DC Output	348,389.9	-0.3%
	Constrained DC Output	348,277.4	-0.0%
	Inverter Output	341,311.8	-2.0%
	Energy to Grid	**339,605.3**	**-0.5%**

Temperature Metrics

Avg. Operating Ambient Temp	11.9°C
Avg. Operating Cell Temp	19.2°C

Simulation Metrics

Operating Hours	4,669
Solved Hours	4,669
Pending Hours	-
Error Hours	-

Condition Set

Description	Condition Set 1
Weather Dataset	TMY10km grid (42.85,-70.95)NREL(prospector) (download)
Solar Angle Location	Meteo Lat/Lng
Transposition Model	Perez Model
Temperature Model	Sandia Model

Temperature Model Parameters

Rack Type	a	b	Temperature Delta
Fixed Tilt	-3.56	-0.08	3.0°C
Flush Mount	-2.81	-0.05	0.0°C
East-West	-3.56	-0.08	3.0°C
Carport	-3.56	-0.08	3.0°C

Soiling (%)

J	F	M	A	M	J	J	A	S	O	N	D
2	2	2	2	2	2	2	2	2	2	2	2

Irradiation Variance	5.0%
Cell Temperature Spread	4.0°C
Module Binning Range	-2.5% to 2.5%
AC System Derate	0.50%

Component Characterizations

Type	Component	Characterization
Module	LG450S2W-U6 (1000V) (LG)	Spec Sheet Characterization,PAN
Module	LG450S2W-U6 (1000V) (LG)	Spec Sheet Characterization,PAN
Module	LG450S2W-U6 (1000V) (LG)	Spec Sheet Characterization,PAN
Inverter	Sunny Tripower X 30-US (SMA)	Spec Sheet

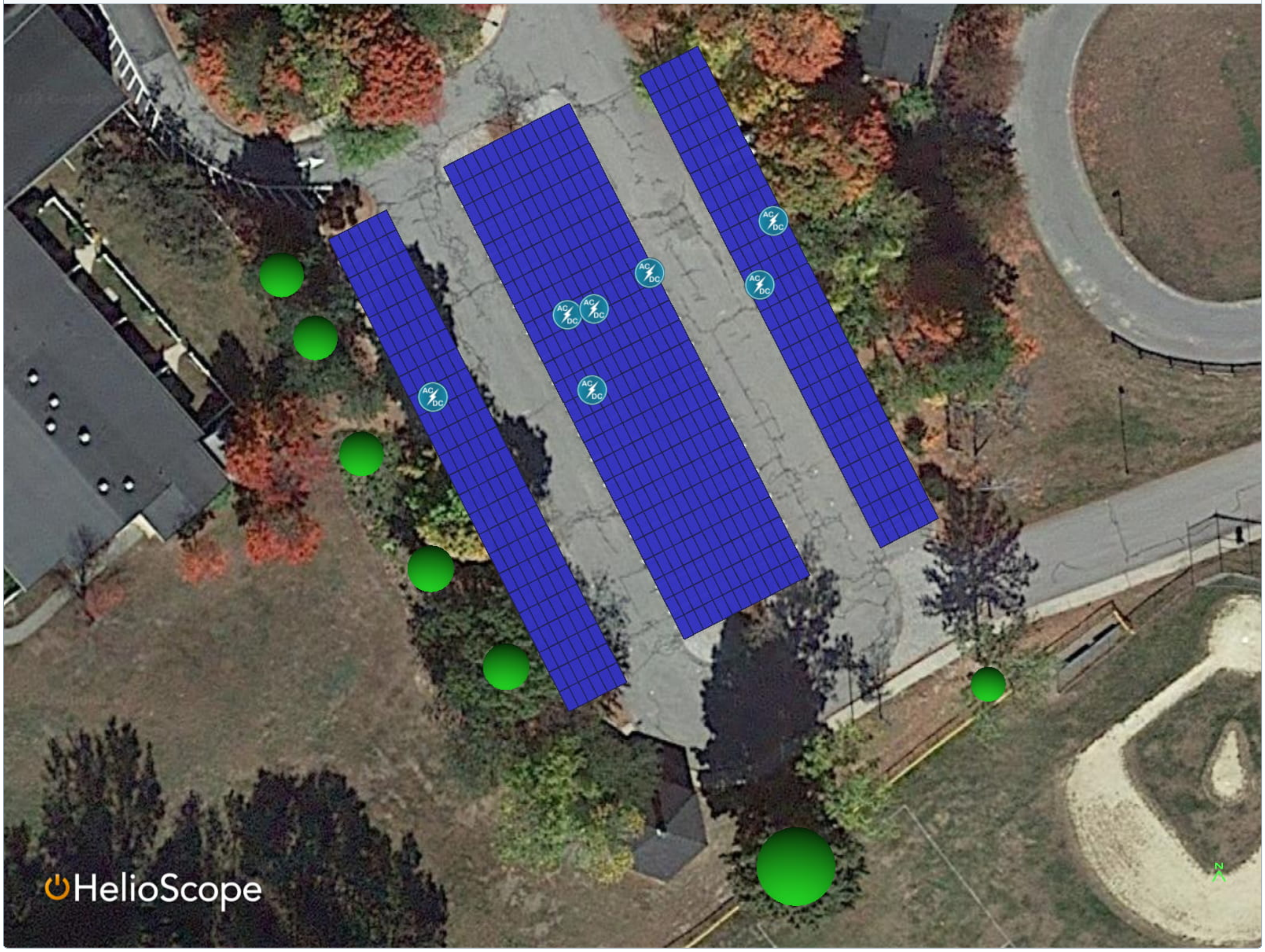
Design BOM

Component	Type	Quantity
Sunny Tripower X 30-US	Inverters	8
LG450S2W-U6 (1000V)	Modules	600
10 AWG (Copper)	Strings	40

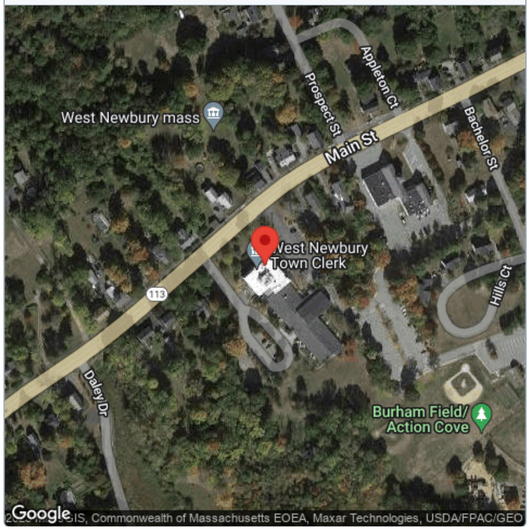
Monthly Shading

Month	GHI (kWh/m²)	POA (kWh/m²)	Shaded (kWh/m²)	Nameplate (kWh)	Grid (kWh)
January	60.4	65.4	64.2	15,858.4	15,355.9
February	81.1	85.8	84.6	21,196.9	20,646.5
March	125.9	130.7	129.5	32,832.2	31,496.9
April	146.3	147.7	146.8	37,506.8	34,961.4
May	169.5	171.1	170.1	43,580.4	39,892.4
June	171.2	172.0	171.1	43,776.4	39,287.2
July	188.3	189.2	188.2	48,242.4	42,712.5
August	160.2	162.9	162.0	41,439.1	36,889.1
September	128.4	132.2	131.2	33,356.7	30,104.0
October	89.4	93.3	92.3	23,272.1	21,499.8
November	60.3	64.9	63.9	15,930.7	15,009.4
December	46.4	50.3	49.5	12,210.0	11,750.2

Design Render



Project Location



Design Wiring Zone

Description	Combiner Poles	String Size	Stringing Strategy
Wiring Zone	-	13 - 17	Along Racking

Field Segments

Description	Racking	Orientation	Tilt	Azimuth	Intrarow Spacing	Frame Size	Frames	Modules	Power
Field Segment 1	Carport	Landscape (Horizontal)	7°	242.992°	0.0 ft	1x1	312	312	140.40 kW
Field Segment 2	Carport	Landscape (Horizontal)	7°	242.992°	0.0 ft	1x1	144	144	64.80 kW
Field Segment 3	Carport	Landscape (Horizontal)	7°	242.992°	0.0 ft	1x1	144	144	64.80 kW

1.3 Public Safety Parking Lot West Newbury 381 Main St, West Newbury, MA 01985, USA

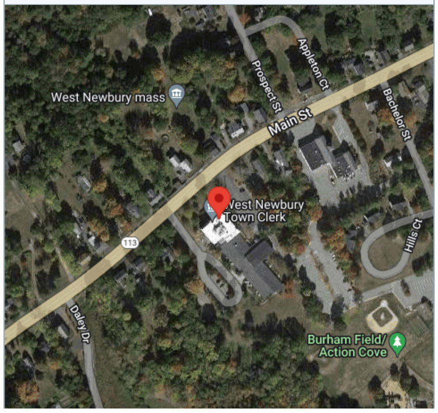
Project Details

Address	381 Main St, West Newbury, MA 01985, USA
Owner	Gabrielle Cole
Last Modified	Gabrielle Cole a few seconds ago
Location	(42.80050330000001, -70.9892665) (GMT -5)
Profile	Default Commercial

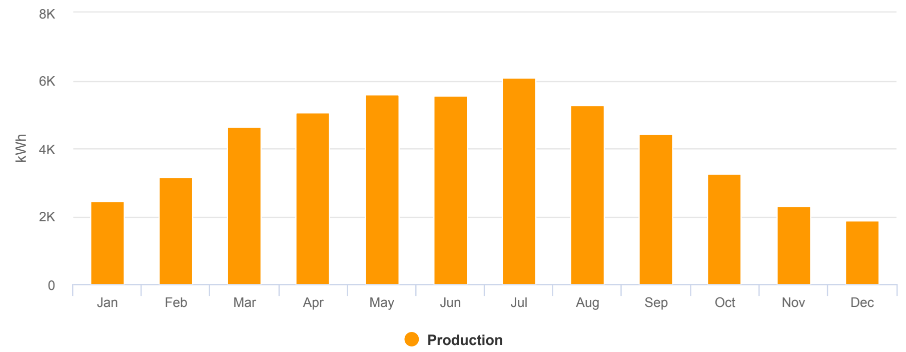
System Metrics

Design	1.3 Public Safety Parking Lot
Module DC Nameplate	37.8 kW
Inverter AC Nameplate	30.0 kW Load Ratio: 1.26
Annual Production	49.6 MWh
Performance Ratio	86.8%
kWh/kWp	1,312.6
Weather Dataset	TMY, 10km grid (42.85,-70.95), NREL (prospector)
Simulator Version	e0419dc019-dcabad097e-4d5d0f02fa-0e176ffd8f

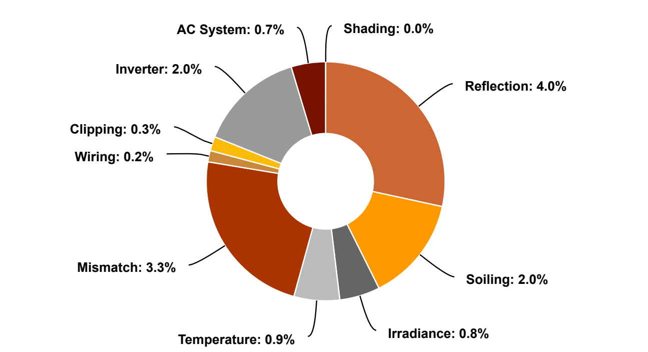
Project Location



Production



System Loss



Annual Production

	Description	Output	% Delta
Irradiance (kWh/m^2)	Annual Global Horizontal Irradiance	1,427.4	-
	POA Irradiance	1,512.0	5.9%
	Shaded Irradiance	1,512.0	-0.0%
	Irradiance After Reflection	1,451.7	-4.0%
	Irradiance After Soiling	1,422.7	-2.0%
	Total Collector Irradiance	**1,422.7**	**0.0%**
Energy (kWh)	Nameplate	53,827.1	-
	Output at Irradiance Levels	53,413.4	-0.8%
	Output at Cell Temperature Derate	52,948.6	-0.9%
	Output After Mismatch	51,213.9	-3.3%
	Optimal DC Output	51,104.0	-0.2%
	Constrained DC Output	50,964.7	-0.3%
	Inverter Output	49,942.7	-2.0%
	Energy to Grid	**49,616.2**	**-0.7%**

Temperature Metrics	
Avg. Operating Ambient Temp	11.9°C
Avg. Operating Cell Temp	19.5°C

Simulation Metrics	
Operating Hours	4,669
Solved Hours	4,669
Pending Hours	-
Error Hours	-

Condition Set

Description	Condition Set 1
Weather Dataset	TMY10km grid (42.85,-70.95)NREL(prospector) (download)
Solar Angle Location	Meteo Lat/Lng
Transposition Model	Perez Model
Temperature Model	Sandia Model

Temperature Model Parameters

Rack Type	a	b	Temperature Delta
Fixed Tilt	-3.56	-0.08	3.0°C
Flush Mount	-2.81	-0.05	0.0°C
East-West	-3.56	-0.08	3.0°C
Carport	-3.56	-0.08	3.0°C

Soiling (%)

J	F	M	A	M	J	J	A	S	O	N	D
2	2	2	2	2	2	2	2	2	2	2	2

Irradiation Variance	5.0%
Cell Temperature Spread	4.0°C
Module Binning Range	-2.5% to 2.5%
AC System Derate	0.50%

Component Characterizations

Type	Component	Characterization
Module	LG450S2W-U6 (1000V) (LG)	Spec Sheet Characterization,PAN
Inverter	Sunny Tripower X 30-US (SMA)	Spec Sheet

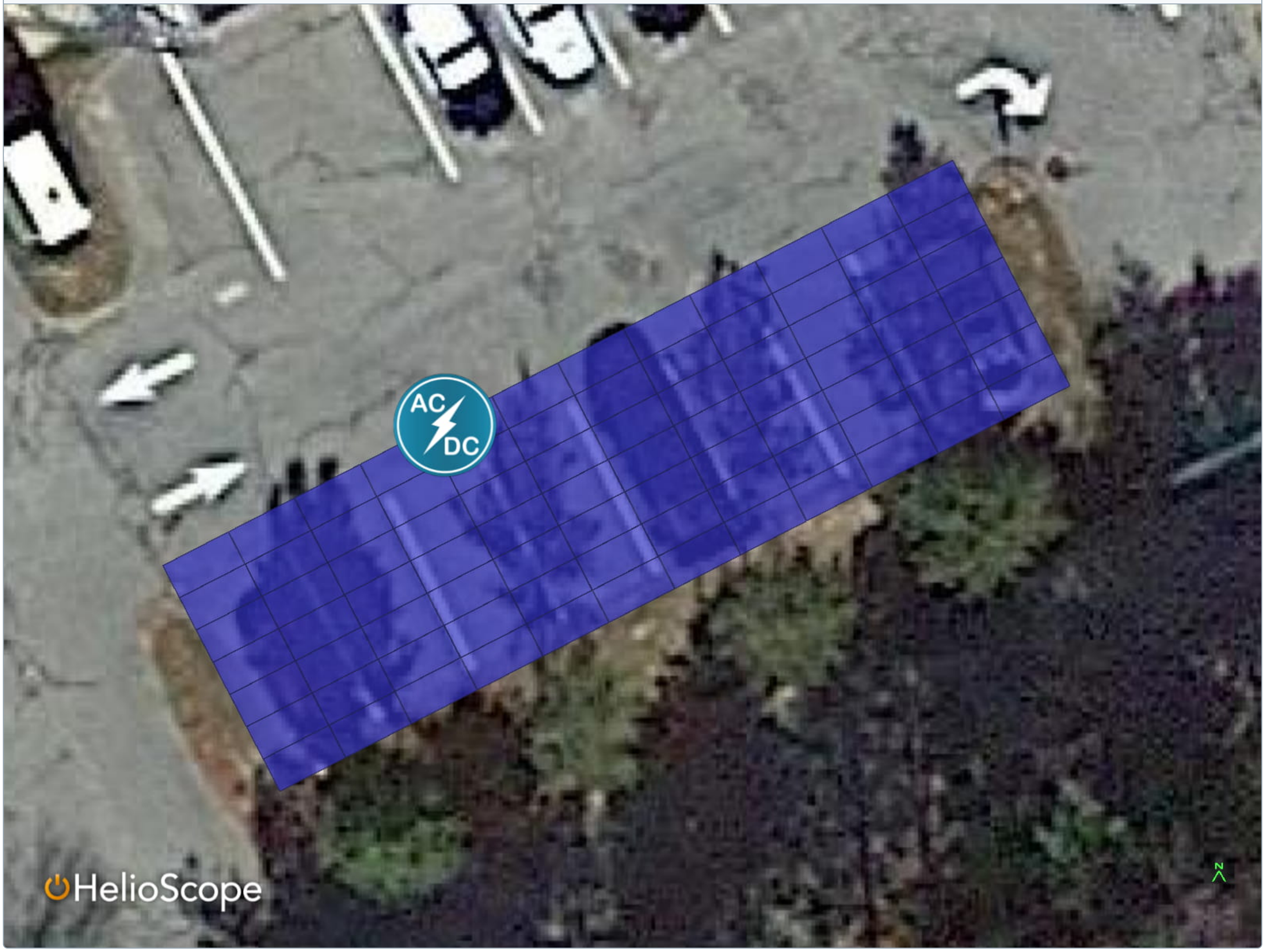
Design BOM

Component	Type	Quantity
1/0 AWG (Aluminum)	AC Home Runs	1
Sunny Tripower X 30-US	Inverters	1
LG450S2W-U6 (1000V)	Modules	84
10 AWG (Copper)	Strings	6

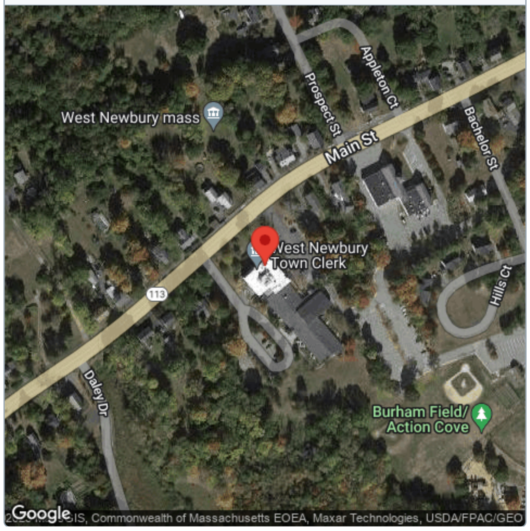
Monthly Shading

Month	GHI (kWh/m^2)	POA (kWh/m^2)	Shaded (kWh/m^2)	Nameplate (kWh)	Grid (kWh)
January	60.4	71.0	71.0	2,468.1	2,431.1
February	81.1	90.8	90.7	3,193.0	3,141.9
March	125.9	135.4	135.4	4,814.7	4,643.9
April	146.3	152.7	152.7	5,465.5	5,050.3
May	169.5	172.8	172.8	6,195.6	5,608.1
June	171.2	173.2	173.2	6,203.3	5,540.5
July	188.3	191.7	191.7	6,879.8	6,085.6
August	160.2	165.5	165.5	5,926.4	5,281.5
September	128.4	136.6	136.6	4,871.0	4,414.7
October	89.4	98.9	98.9	3,500.6	3,258.2
November	60.3	68.5	68.5	2,397.5	2,291.3
December	46.4	55.0	55.0	1,911.6	1,869.1

Design Render



Project Location



Design Wiring Zone

Description	Combiner Poles	String Size	Stringing Strategy
Wiring Zone	-	13 - 17	Along Racking

Field Segments

Description	Racking	Orientation	Tilt	Azimuth	Intrarow Spacing	Frame Size	Frames	Modules	Power
Field Segment 1	Carport	Landscape (Horizontal)	7°	152.834°	0.0 ft	1x1	84	84	37.80 kW

1.4 Burnham Field Parking Lot West Newbury 381 Main St, West Newbury, MA 01985, USA

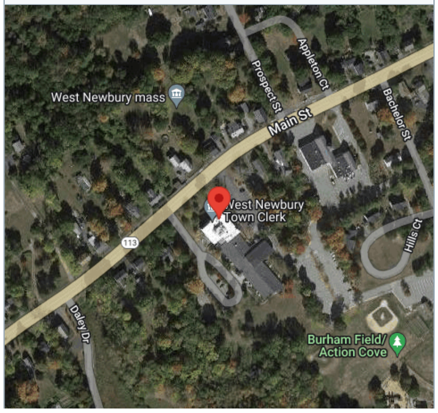
Project Details

Address	381 Main St, West Newbury, MA 01985, USA
Owner	Gabrielle Cole
Last Modified	Gabrielle Cole a few seconds ago
Location	(42.80050330000001, -70.9892665) (GMT -5)
Profile	Default Commercial

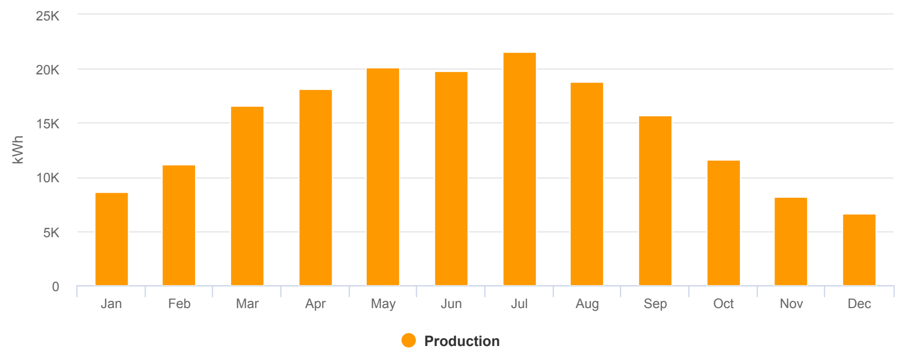
System Metrics

Design	1.4 Burnham Field Parking Lot
Module DC Nameplate	134.6 kW
Inverter AC Nameplate	120.0 kW Load Ratio: 1.12
Annual Production	177.0 MWh
Performance Ratio	86.7%
kWh/kWp	1,315.6
Weather Dataset	TMY, 10km grid (42.85,-70.95), NREL (prospector)
Simulator Version	e0419dc019-dcabad097e-4d5d0f02fa-0e176ffd8f

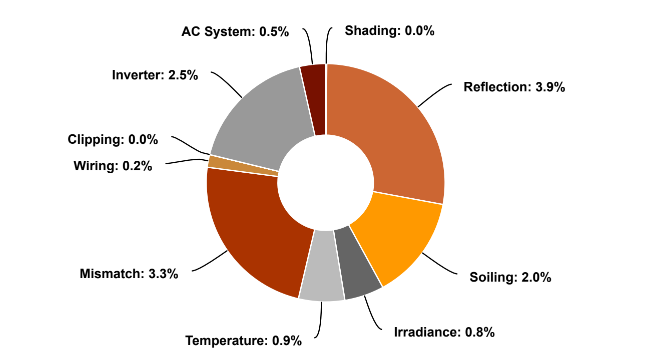
Project Location



Production



System Loss



Annual Production

	Description	Output	% Delta
Irradiance (kWh/m^2)	Annual Global Horizontal Irradiance	1,427.4	-
	POA Irradiance	1,517.3	6.3%
	Shaded Irradiance	1,517.0	-0.0%
	Irradiance After Reflection	1,457.3	-3.9%
	Irradiance After Soiling	1,428.1	-2.0%
	Total Collector Irradiance	**1,428.1**	**-0.0%**
Energy (kWh)	Nameplate	192,338.7	-
	Output at Irradiance Levels	190,877.1	-0.8%
	Output at Cell Temperature Derate	189,187.7	-0.9%
	Output After Mismatch	182,914.5	-3.3%
	Optimal DC Output	182,469.3	-0.2%
	Constrained DC Output	182,465.9	-0.0%
	Inverter Output	177,904.2	-2.5%
	Energy to Grid	**177,014.7**	**-0.5%**

Temperature Metrics

Avg. Operating Ambient Temp	11.9°C
Avg. Operating Cell Temp	19.5°C

Simulation Metrics

Operating Hours	4,669
Solved Hours	4,669
Pending Hours	-
Error Hours	-

Condition Set

Description	Condition Set 1
Weather Dataset	TMY10km grid (42.85,-70.95)NREL(prospector) (download)
Solar Angle Location	Meteo Lat/Lng
Transposition Model	Perez Model
Temperature Model	Sandia Model

Temperature Model Parameters

Rack Type	a	b	Temperature Delta
Fixed Tilt	-3.56	-0.08	3.0°C
Flush Mount	-2.81	-0.05	0.0°C
East-West	-3.56	-0.08	3.0°C
Carport	-3.56	-0.08	3.0°C

Soiling (%)

J	F	M	A	M	J	J	A	S	O	N	D
2	2	2	2	2	2	2	2	2	2	2	2

Irradiation Variance	5.0%
Cell Temperature Spread	4.0°C
Module Binning Range	-2.5% to 2.5%
AC System Derate	0.50%

Component Characterizations

Type	Component	Characterization
Module	LG450S2W-U6 (1000V) (LG)	Spec Sheet Characterization,PAN
Inverter	Sunny Tripower X 20-US (SMA)	Spec Sheet

Design BOM

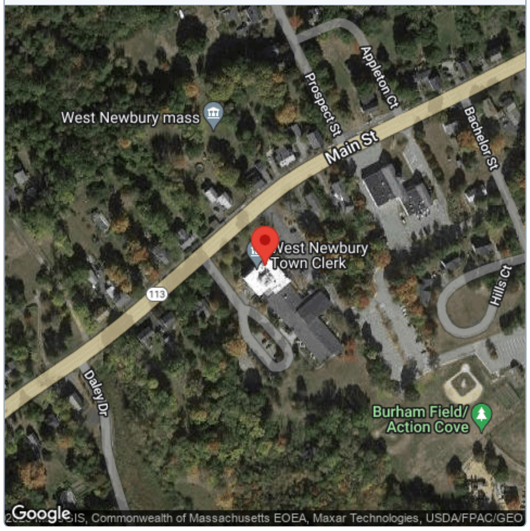
Component	Type	Quantity
Sunny Tripower X 20-US	Inverters	6
LG450S2W-U6 (1000V)	Modules	299
10 AWG (Copper)	Strings	18

Monthly Shading

Month	GHI (kWh/m^2)	POA (kWh/m^2)	Shaded (kWh/m^2)	Nameplate (kWh)	Grid (kWh)
January	60.4	71.7	71.6	8,876.4	8,679.7
February	81.1	91.4	91.4	11,454.6	11,211.4
March	125.9	136.1	136.1	17,229.5	16,563.4
April	146.3	152.9	152.9	19,483.0	18,105.7
May	169.5	173.0	173.0	22,092.0	20,138.0
June	171.2	173.3	173.3	22,101.6	19,757.2
July	188.3	191.8	191.8	24,509.8	21,614.9
August	160.2	165.9	165.9	21,152.7	18,778.9
September	128.4	137.1	137.1	17,411.3	15,710.0
October	89.4	99.4	99.4	12,531.6	11,601.1
November	60.3	69.1	69.1	8,622.3	8,184.3
December	46.4	55.5	55.5	6,874.0	6,670.1

Design Render

Project Location



Design Wiring Zone

Description	Combiner Poles	String Size	Stringing Strategy
Wiring Zone	-	9 - 17	Along Racking

Field Segments

Description	Racking	Orientation	Tilt	Azimuth	Intrarow Spacing	Frame Size	Frames	Modules	Power
Field Segment 1	Carport	Landscape (Horizontal)	7°	161.859°	0.0 ft	1x1	299	299	134.55 kW

1.5 DPW Ground Mount West Newbury 381 Main St, West Newbury, MA 01985, USA

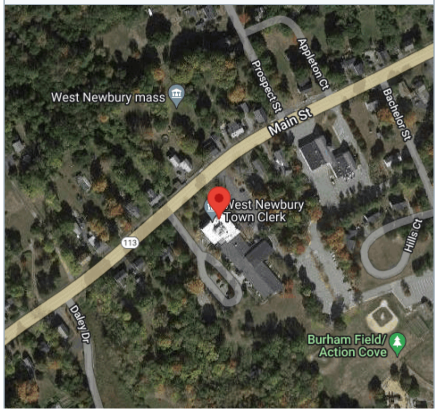
Project Details

Address	381 Main St, West Newbury, MA 01985, USA
Owner	Gabrielle Cole
Last Modified	Gabrielle Cole a few seconds ago
Location	(42.80050330000001, -70.9892665) (GMT -5)
Profile	Default Commercial

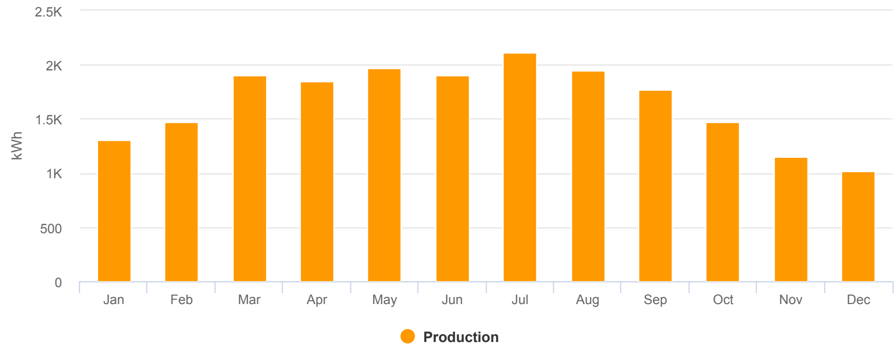
System Metrics

Design	1.5 DPW Ground Mount
Module DC Nameplate	14.4 kW
Inverter AC Nameplate	12.0 kW Load Ratio: 1.20
Annual Production	19.9 MWh
Performance Ratio	81.0%
kWh/kWp	1,380.5
Weather Dataset	TMY, 10km grid (42.85,-70.95), NREL (prospector)
Simulator Version	e0419dc019-dcabad097e-4d5d0f02fa-0e176ffd8f

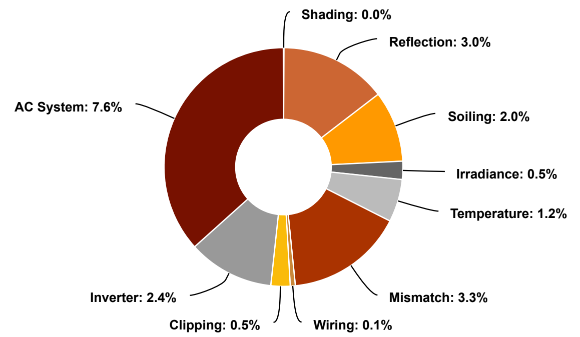
Project Location



Production



System Loss



Annual Production

	Description	Output	% Delta
Irradiance (kWh/m^2)	Annual Global Horizontal Irradiance	1,427.4	-
	POA Irradiance	1,704.7	19.4%
	Shaded Irradiance	1,704.5	-0.0%
	Irradiance After Reflection	1,653.3	-3.0%
	Irradiance After Soiling	1,620.2	-2.0%
	Total Collector Irradiance	**1,620.2**	**0.0%**
Energy (kWh)	Nameplate	23,353.5	-
	Output at Irradiance Levels	23,233.8	-0.5%
	Output at Cell Temperature Derate	22,955.3	-1.2%
	Output After Mismatch	22,197.1	-3.3%
	Optimal DC Output	22,165.3	-0.1%
	Constrained DC Output	22,045.7	-0.5%
	Inverter Output	21,513.7	-2.4%
	Energy to Grid	**19,879.4**	**-7.6%**

Temperature Metrics

Avg. Operating Ambient Temp	11.9°C
Avg. Operating Cell Temp	20.5°C

Simulation Metrics

Operating Hours	4,669
Solved Hours	4,669
Pending Hours	-
Error Hours	-

Condition Set

Description	Condition Set 1
Weather Dataset	TMY10km grid (42.85,-70.95)NREL(prospector) (download)
Solar Angle Location	Meteo Lat/Lng
Transposition Model	Perez Model
Temperature Model	Sandia Model

Temperature Model Parameters

Rack Type	a	b	Temperature Delta
Fixed Tilt	-3.56	-0.08	3.0°C
Flush Mount	-2.81	-0.05	0.0°C
East-West	-3.56	-0.08	3.0°C
Carport	-3.56	-0.08	3.0°C

Soiling (%)

J	F	M	A	M	J	J	A	S	O	N	D
2	2	2	2	2	2	2	2	2	2	2	2

Irradiation Variance	5.0%
Cell Temperature Spread	4.0°C
Module Binning Range	-2.5% to 2.5%
AC System Derate	0.50%

Component Characterizations

Type	Component	Characterization
Module	LG450S2W-U6 (1000V) (LG)	Spec Sheet Characterization,PAN
Module	LG450S2W-U6 (1000V) (LG)	Spec Sheet Characterization,PAN
Inverter	Sunny Tripower X 12 (415V) (SMA Solar Technology)	Spec Sheet

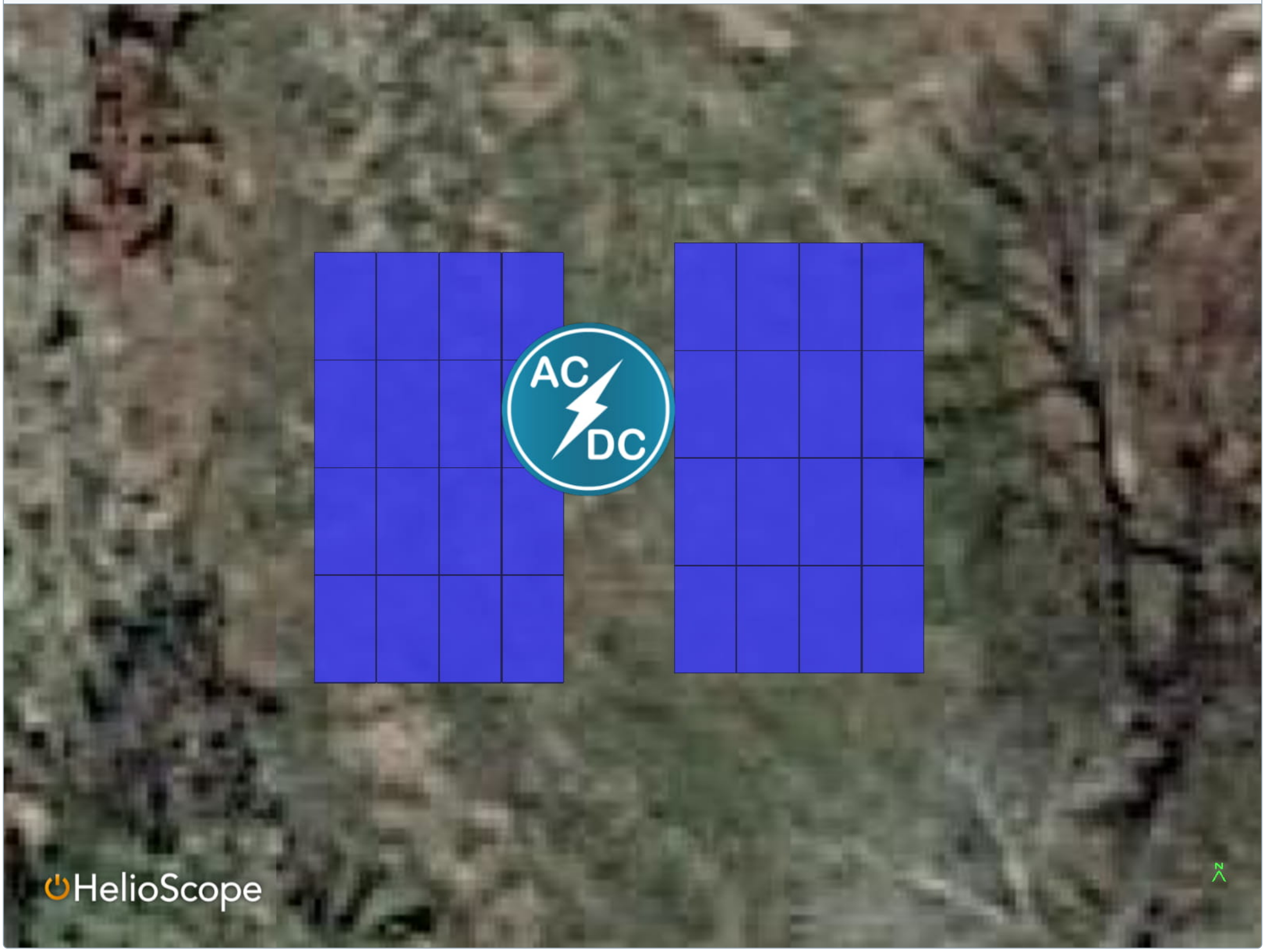
Design BOM

Component	Type	Quantity
1/0 AWG (Aluminum)	AC Home Runs	1
2 input Combiners	Combiners	1
Sunny Tripower X 12 (415V)	Inverters	1
LG450S2W-U6 (1000V)	Modules	32
10 AWG (Copper)	Strings	2

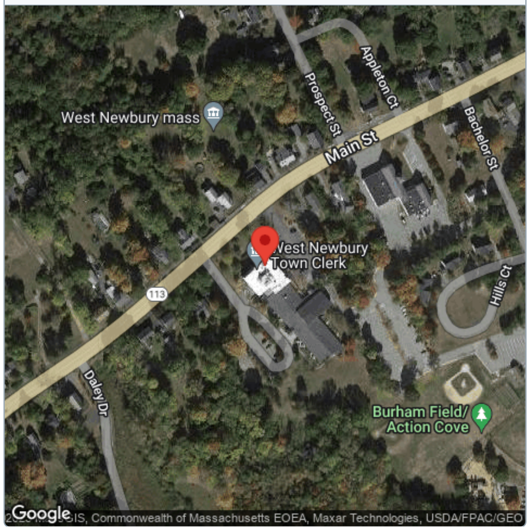
Monthly Shading

Month	GHI (kWh/m^2)	POA (kWh/m^2)	Shaded (kWh/m^2)	Nameplate (kWh)	Grid (kWh)
January	60.4	105.1	105.0	1,438.7	1,309.0
February	81.1	119.6	119.5	1,638.2	1,476.6
March	125.9	160.6	160.5	2,202.4	1,903.9
April	146.3	161.4	161.4	2,212.6	1,851.1
May	169.5	172.3	172.3	2,358.1	1,968.9
June	171.2	167.5	167.4	2,286.4	1,904.1
July	188.3	188.2	188.2	2,576.2	2,111.5
August	160.2	172.7	172.7	2,366.9	1,942.7
September	128.4	155.6	155.6	2,135.3	1,771.6
October	89.4	125.1	125.1	1,717.1	1,466.8
November	60.3	94.8	94.7	1,298.7	1,153.1
December	46.4	81.9	81.9	1,122.8	1,020.2

Design Render



Project Location



Design Wiring Zone

Description	Combiner Poles	String Size	Stringing Strategy
Wiring Zone	12	6 - 17	Along Racking

Field Segments

Description	Racking	Orientation	Tilt	Azimuth	Intrarow Spacing	Frame Size	Frames	Modules	Power
Field Segment 1	Carport	Portrait (Vertical)	30°	180°	0.0 ft	1x1	16	16	7.20 kW
Field Segment 1 (copy)	Carport	Portrait (Vertical)	30°	180°	0.0 ft	1x1	16	16	7.20 kW

1.5 DPW Salt Shed Roof West Newbury 381 Main St, West Newbury, MA 01985, USA

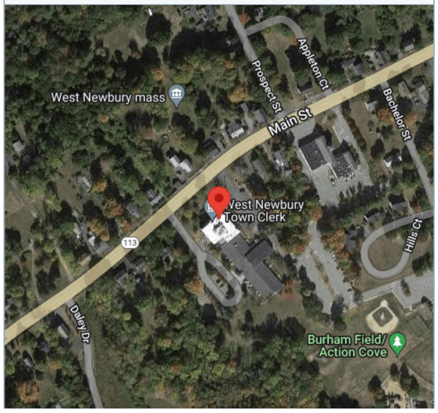
Project Details

Address	381 Main St, West Newbury, MA 01985, USA
Owner	Gabrielle Cole
Last Modified	Gabrielle Cole a few seconds ago
Location	(42.80050330000001, -70.9892665) (GMT -5)
Profile	Default Commercial

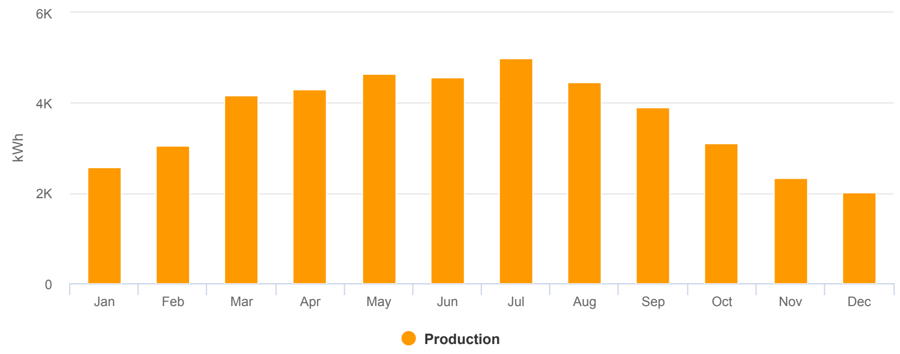
System Metrics

Design	1.5 DPW Salt Shed Roof
Module DC Nameplate	36.9 kW
Inverter AC Nameplate	33.3 kW Load Ratio: 1.11
Annual Production	44.1 MWh
Performance Ratio	74.2%
kWh/kWp	1,196.5
Weather Dataset	TMY, 10km grid (42.85,-70.95), NREL (prospector)
Simulator Version	e0419dc019-dcabad097e-4d5d0f02fa-0e176ffd8f

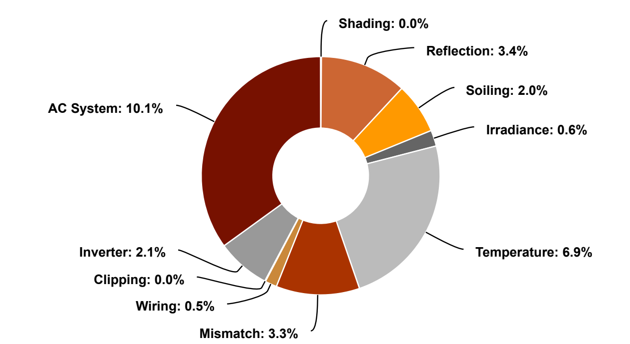
Project Location



Production



System Loss



Annual Production

	Description	Output	% Delta
Irradiance (kWh/m^2)	Annual Global Horizontal Irradiance	1,427.4	-
	POA Irradiance	1,612.0	12.9%
	Shaded Irradiance	1,611.5	-0.0%
	Irradiance After Reflection	1,556.4	-3.4%
	Irradiance After Soiling	1,525.3	-2.0%
	Total Collector Irradiance	**1,525.3**	**0.0%**
Energy (kWh)	Nameplate	56,340.7	-
	Output at Irradiance Levels	55,987.5	-0.6%
	Output at Cell Temperature Derate	52,137.3	-6.9%
	Output After Mismatch	50,427.6	-3.3%
	Optimal DC Output	50,193.5	-0.5%
	Constrained DC Output	50,180.6	-0.0%
	Inverter Output	49,125.0	-2.1%
	Energy to Grid	**44,149.1**	**-10.1%**
Temperature Metrics			
	Avg. Operating Ambient Temp		11.9°C
	Avg. Operating Cell Temp		28.6°C
Simulation Metrics			
	Operating Hours		4,669
	Solved Hours		4,669
	Pending Hours		-
	Error Hours		-

Condition Set

Description	Condition Set 1
Weather Dataset	TMY10km grid (42.85,-70.95)NREL(prospector) (download)
Solar Angle Location	Meteo Lat/Lng
Transposition Model	Perez Model
Temperature Model	Sandia Model

Temperature Model Parameters

Rack Type	a	b	Temperature Delta
Fixed Tilt	-3.56	-0.08	3.0°C
Flush Mount	-2.81	-0.05	0.0°C
East-West	-3.56	-0.08	3.0°C
Carport	-3.56	-0.08	3.0°C

Soiling (%)

J	F	M	A	M	J	J	A	S	O	N	D
2	2	2	2	2	2	2	2	2	2	2	2

Irradiation Variance	5.0%
Cell Temperature Spread	4.0°C
Module Binning Range	-2.5% to 2.5%
AC System Derate	0.50%

Component Characterizations

Type	Component	Characterization
Module	LG450S2W-U6 (1000V) (LG)	Spec Sheet Characterization,PAN
Module	LG450S2W-U6 (1000V) (LG)	Spec Sheet Characterization,PAN
Inverter	Sunny Tripower_Core1 33-US-41 (SMA)	Default Characterization

Design BOM

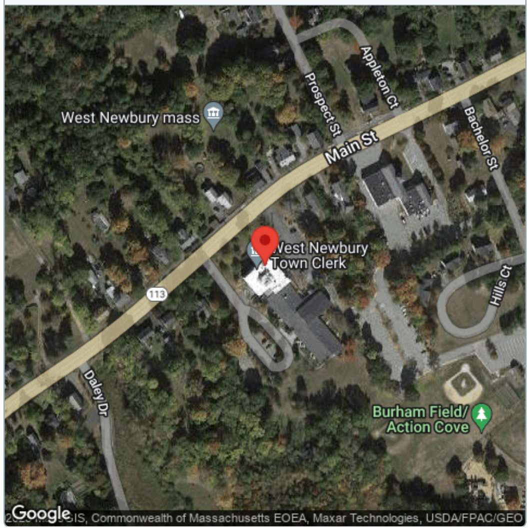
Component	Type	Quantity
1/0 AWG (Aluminum)	AC Home Runs	1
2 input Combiners	Combiners	1
3 input Combiners	Combiners	1
12 AWG (Copper)	Home Runs	2
Sunny Tripower_Core1 33-US-41	Inverters	1
LG450S2W-U6 (1000V)	Modules	82
10 AWG (Copper)	Strings	5

Monthly Shading

Month	GHI (kWh/m^2)	POA (kWh/m^2)	Shaded (kWh/m^2)	Nameplate (kWh)	Grid (kWh)
January	60.4	86.1	86.1	2,977.5	2,576.9
February	81.1	103.9	103.8	3,609.0	3,063.8
March	125.9	147.5	147.5	5,156.8	4,180.0
April	146.3	158.9	158.9	5,574.6	4,307.0
May	169.5	174.6	174.5	6,122.4	4,658.1
June	171.2	173.0	172.9	6,057.1	4,572.9
July	188.3	193.0	192.9	6,771.5	4,996.3
August	160.2	170.4	170.4	5,972.9	4,452.3
September	128.4	146.3	146.3	5,123.4	3,897.0
October	89.4	111.4	111.3	3,885.6	3,099.0
November	60.3	79.9	79.9	2,771.4	2,336.6
December	46.4	67.0	67.0	2,318.5	2,009.3

Design Render

Project Location



Design Wiring Zone

Description	Combiner Poles	String Size	Stringing Strategy
Wiring Zone	12	4 - 17	Along Racking

Field Segments

Description	Racking	Orientation	Tilt	Azimuth	Intrarow Spacing	Frame Size	Frames	Modules	Power
Field Segment 1	Flush Mount	Landscape (Horizontal)	20°	160.161°	0.0 ft	1x5	10	50	22.50 kW
Field Segment 2	Flush Mount	Landscape (Horizontal)	12°	160.161°	0.0 ft	1x4	8	32	14.40 kW

1.5 Pipestave Parking Lot West Newbury 381 Main St, West Newbury, MA 01985, USA

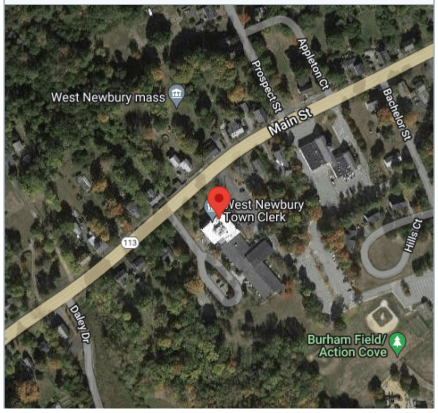
Project Details

Address	381 Main St, West Newbury, MA 01985, USA
Owner	Gabrielle Cole
Last Modified	Gabrielle Cole a few seconds ago
Location	(42.80050330000001, -70.9892665) (GMT -5)
Profile	Default Commercial

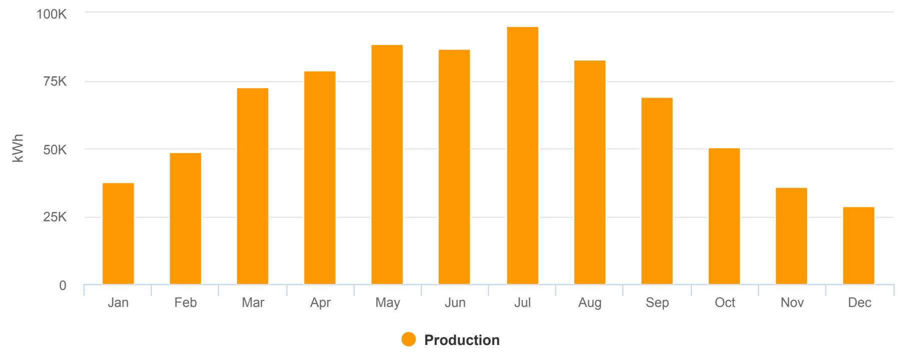
System Metrics

Design	1.5 Pipestave Parking Lot
Module DC Nameplate	595.4 kW
Inverter AC Nameplate	480.0 kW Load Ratio: 1.24
Annual Production	774.7 MWh
Performance Ratio	86.2%
kWh/kWp	1,301.3
Weather Dataset	TMY, 10km grid (42.85,-70.95), NREL (prospector)
Simulator Version	e0419dc019-dcabad097e-4d5d0f02fa-0e176ffd8f

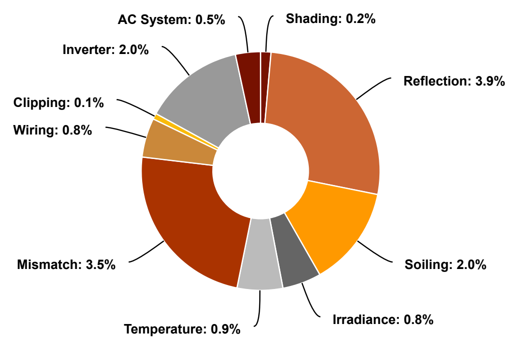
Project Location



Production



System Loss



Annual Production

	Description	Output	% Delta
Irradiance (kWh/m^2)	Annual Global Horizontal Irradiance	1,427.4	-
	POA Irradiance	1,509.1	5.7%
	Shaded Irradiance	1,506.0	-0.2%
	Irradiance After Reflection	1,446.7	-3.9%
	Irradiance After Soiling	1,417.7	-2.0%
	Total Collector Irradiance	**1,417.7**	**-0.0%**
Energy (kWh)	Nameplate	844,840.6	-
	Output at Irradiance Levels	838,316.0	-0.8%
	Output at Cell Temperature Derate	830,677.6	-0.9%
	Output After Mismatch	801,712.8	-3.5%
	Optimal DC Output	795,433.2	-0.8%
	Constrained DC Output	794,505.0	-0.1%
	Inverter Output	778,596.8	-2.0%
	Energy to Grid	**774,703.9**	**-0.5%**

Temperature Metrics

Avg. Operating Ambient Temp	11.9°C
Avg. Operating Cell Temp	19.4°C

Simulation Metrics

Operating Hours	4,669
Solved Hours	4,669
Pending Hours	-
Error Hours	-

Condition Set

Description	Condition Set 1
Weather Dataset	TMY10km grid (42.85,-70.95)NREL(prospector) (download)
Solar Angle Location	Meteo Lat/Lng
Transposition Model	Perez Model
Temperature Model	Sandia Model

Temperature Model Parameters

Rack Type	a	b	Temperature Delta
Fixed Tilt	-3.56	-0.08	3.0°C
Flush Mount	-2.81	-0.05	0.0°C
East-West	-3.56	-0.08	3.0°C
Carport	-3.56	-0.08	3.0°C

Soiling (%)

J	F	M	A	M	J	J	A	S	O	N	D
2	2	2	2	2	2	2	2	2	2	2	2

Irradiation Variance	5.0%
Cell Temperature Spread	4.0°C
Module Binning Range	-2.5% to 2.5%
AC System Derate	0.50%

Component Characterizations

Type	Component	Characterization
Module	LG450S2W-U6 (1000V) (LG)	Spec Sheet Characterization,PAN
Inverter	Sunny Tripower X 30-US (SMA)	Spec Sheet

Design BOM

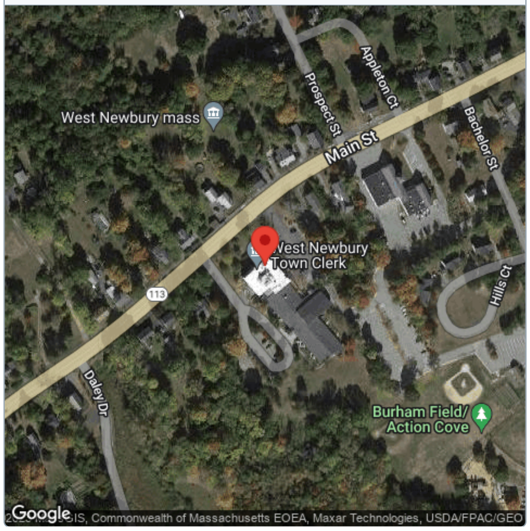
Component	Type	Quantity
2 input Combiners	Combiners	16
3 input Combiners	Combiners	16
12 AWG (Copper)	Home Runs	32
Sunny Tripower X 30-US	Inverters	16
LG450S2W-U6 (1000V)	Modules	1,323
10 AWG (Copper)	Strings	80

Monthly Shading

Month	GHI (kWh/m^2)	POA (kWh/m^2)	Shaded (kWh/m^2)	Nameplate (kWh)	Grid (kWh)
January	60.4	70.8	70.3	38,524.8	37,497.5
February	81.1	90.7	90.3	50,107.9	48,893.6
March	125.9	135.5	135.3	75,795.8	72,691.9
April	146.3	151.3	151.1	85,224.0	78,680.8
May	169.5	172.8	172.6	97,538.3	88,308.3
June	171.2	173.1	172.9	97,558.6	86,927.5
July	188.3	191.1	190.9	107,931.3	94,969.0
August	160.2	165.6	165.4	93,361.4	82,710.5
September	128.4	136.4	136.2	76,541.7	68,935.4
October	89.4	98.2	98.0	54,631.4	50,484.1
November	60.3	68.9	68.5	37,873.7	35,826.9
December	46.4	54.7	54.3	29,751.7	28,778.3

Design Render

Project Location



Design Wiring Zone

Description	Combiner Poles	String Size	Stringing Strategy
Wiring Zone	12	13 - 17	Along Racking

Field Segments

Description	Racking	Orientation	Tilt	Azimuth	Intrarow Spacing	Frame Size	Frames	Modules	Power
Field Segment 1	Carport	Landscape (Horizontal)	7°	206.658°	0.0 ft	1x1	1,323	1,323	595.35 kW

1.6 Page School Ground Mount West Newbury 381 Main St, West Newbury, MA 01985,

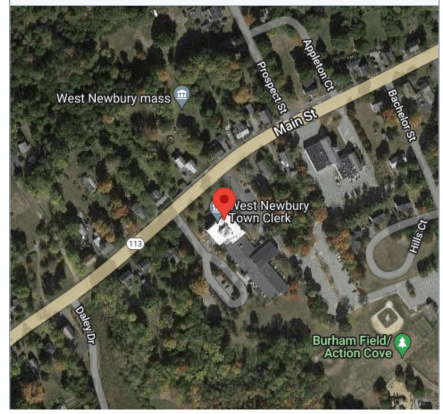
Project Details

Address	381 Main St, West Newbury, MA 01985, USA
Owner	Gabrielle Cole
Last Modified	Gabrielle Cole a few seconds ago
Location	(42.80050330000001, -70.9892665) (GMT -5)
Profile	Default Commercial

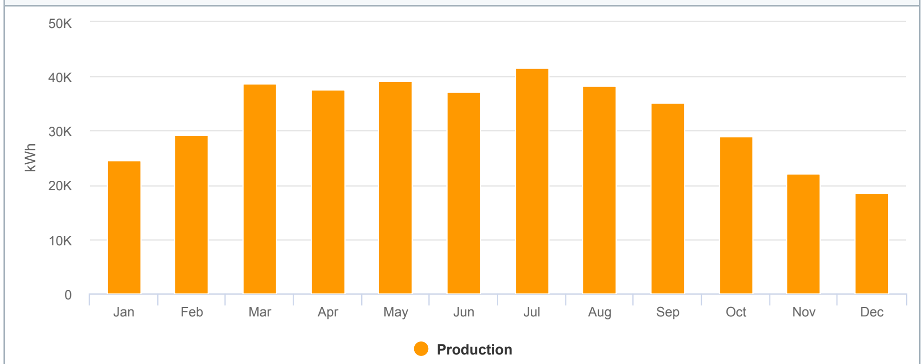
System Metrics

Design	1.6 Page School Ground Mount
Module DC Nameplate	270.0 kW
Inverter AC Nameplate	250.0 kW Load Ratio: 1.08
Annual Production	391.2 MWh
Performance Ratio	85.0%
kWh/kWp	1,448.9
Weather Dataset	TMY, 10km grid (42.85,-70.95), NREL (prospector)
Simulator Version	e0419dc019-dcabad097e-4d5d0f02fa-0e176ffd8f

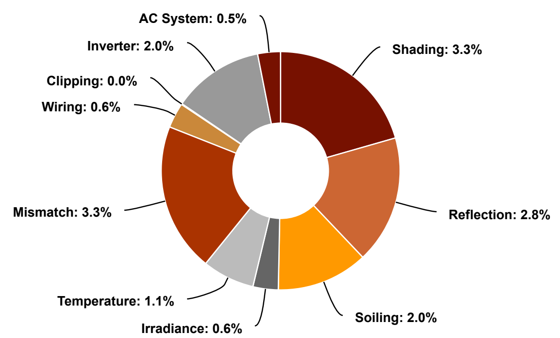
Project Location



Production



System Loss



Annual Production

	Description	Output	% Delta
Irradiance (kWh/m^2)	Annual Global Horizontal Irradiance	1,427.4	-
	POA Irradiance	1,704.7	19.4%
	Shaded Irradiance	1,648.1	-3.3%
	Irradiance After Reflection	1,601.8	-2.8%
	Irradiance After Soiling	1,569.8	-2.0%
	Total Collector Irradiance	**1,569.8**	**-0.0%**
Energy (kWh)	Nameplate	424,254.9	-
	Output at Irradiance Levels	421,905.9	-0.6%
	Output at Cell Temperature Derate	417,092.7	-1.1%
	Output After Mismatch	403,476.9	-3.3%
	Optimal DC Output	401,255.1	-0.6%
	Constrained DC Output	401,186.2	-0.0%
	Inverter Output	393,161.3	-2.0%
	Energy to Grid	**391,195.5**	**-0.5%**

Temperature Metrics

Avg. Operating Ambient Temp	11.9°C
Avg. Operating Cell Temp	20.2°C

Simulation Metrics

Operating Hours	4,669
Solved Hours	4,669
Pending Hours	-
Error Hours	-

Condition Set

Description	Condition Set 1
Weather Dataset	TMY10km grid (42.85,-70.95)NREL(prospector) (download)
Solar Angle Location	Meteo Lat/Lng
Transposition Model	Perez Model
Temperature Model	Sandia Model

Temperature Model Parameters

Rack Type	a	b	Temperature Delta
Fixed Tilt	-3.56	-0.08	3.0°C
Flush Mount	-2.81	-0.05	0.0°C
East-West	-3.56	-0.08	3.0°C
Carport	-3.56	-0.08	3.0°C

Soiling (%)

J	F	M	A	M	J	J	A	S	O	N	D
2	2	2	2	2	2	2	2	2	2	2	2

Irradiation Variance	5.0%
Cell Temperature Spread	4.0°C
Module Binning Range	-2.5% to 2.5%
AC System Derate	0.50%

Component Characterizations

Type	Component	Characterization
Module	LG450S2W-U6 (1000V) (LG)	Spec Sheet Characterization,PAN
Inverter	Sunny Tripower Core1/US (SMA)	Spec Sheet

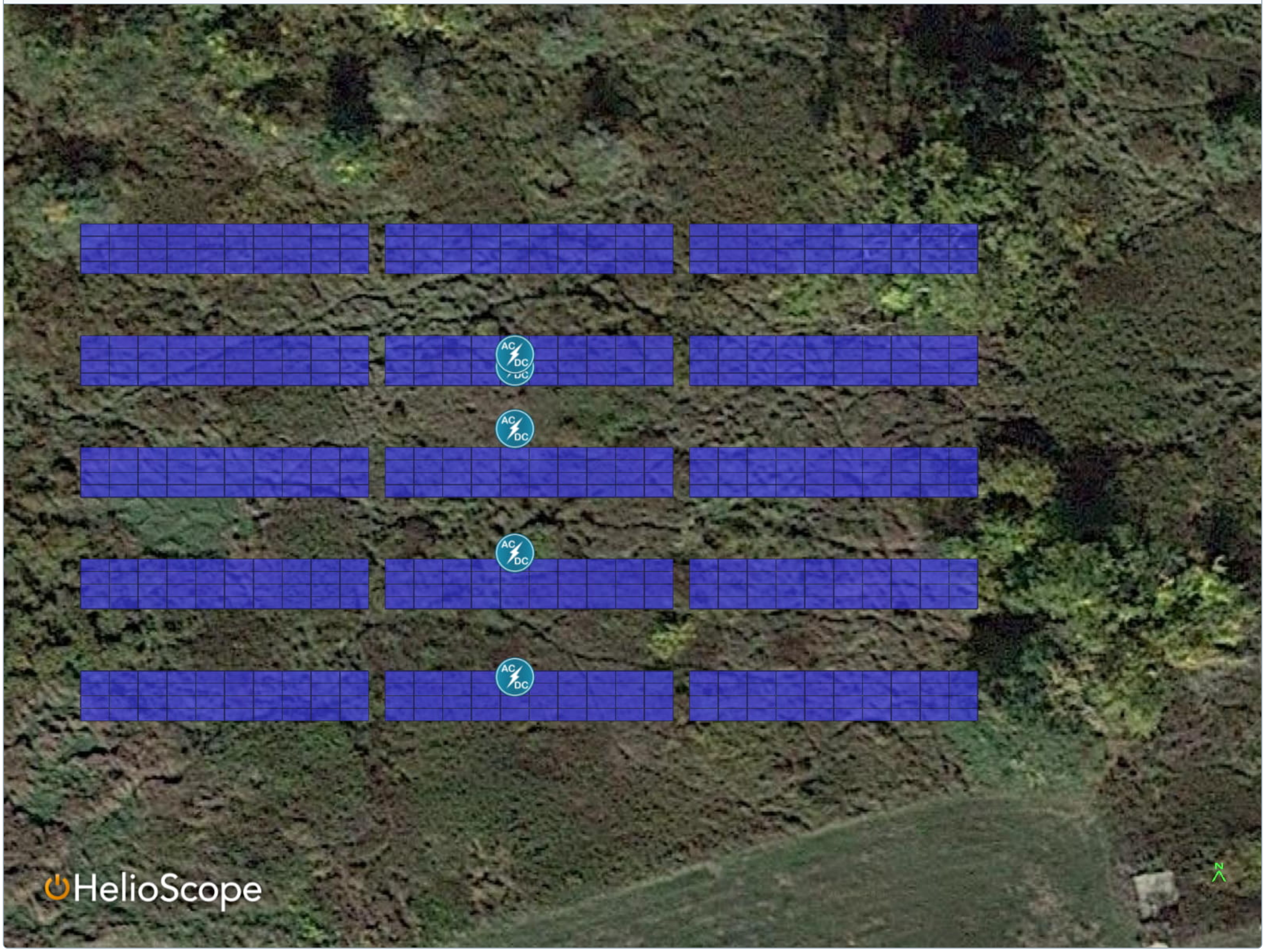
Design BOM

Component	Type	Quantity
8 input Combiners	Combiners	5
12 AWG (Copper)	Home Runs	5
Sunny Tripower Core1/US	Inverters	5
LG450S2W-U6 (1000V)	Modules	600
10 AWG (Copper)	Strings	40

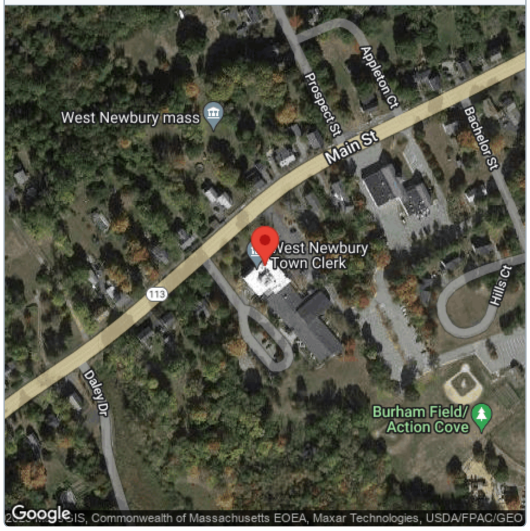
Monthly Shading

Month	GHI (kWh/m^2)	POA (kWh/m^2)	Shaded (kWh/m^2)	Nameplate (kWh)	Grid (kWh)
January	60.4	105.1	97.9	25,205.7	24,543.1
February	81.1	119.6	116.2	29,909.4	29,178.0
March	125.9	160.6	157.0	40,443.6	38,699.0
April	146.3	161.4	157.3	40,511.4	37,541.4
May	169.5	172.3	167.3	43,029.5	39,225.8
June	171.2	167.5	162.2	41,628.8	37,278.6
July	188.3	188.2	182.9	47,045.6	41,542.0
August	160.2	172.7	168.1	43,293.0	38,367.2
September	128.4	155.6	152.0	39,174.6	35,170.5
October	89.4	125.1	122.1	31,484.8	28,973.8
November	60.3	94.8	90.7	23,350.9	22,112.0
December	46.4	81.9	74.5	19,177.6	18,564.2

Design Render



Project Location



Design Wiring Zone

Description	Combiner Poles	String Size	Stringing Strategy
Wiring Zone	12	13 - 17	Along Racking

Field Segments

Description	Racking	Orientation	Tilt	Azimuth	Intrarow Spacing	Frame Size	Frames	Modules	Power
Field Segment 1	Fixed Tilt	Landscape (Horizontal)	30°	180°	15.0 ft	4x10	15	600	270.00 kW

1.7 Dunn Property North Field West Newbury 381 Main St, West Newbury, MA 01985, USA

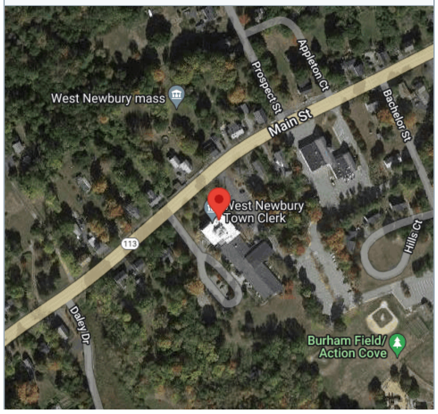
Project Details

Address	381 Main St, West Newbury, MA 01985, USA
Owner	Gabrielle Cole
Last Modified	Gabrielle Cole a minute ago
Location	(42.80050330000001, -70.9892665) (GMT -5)
Profile	Default Commercial

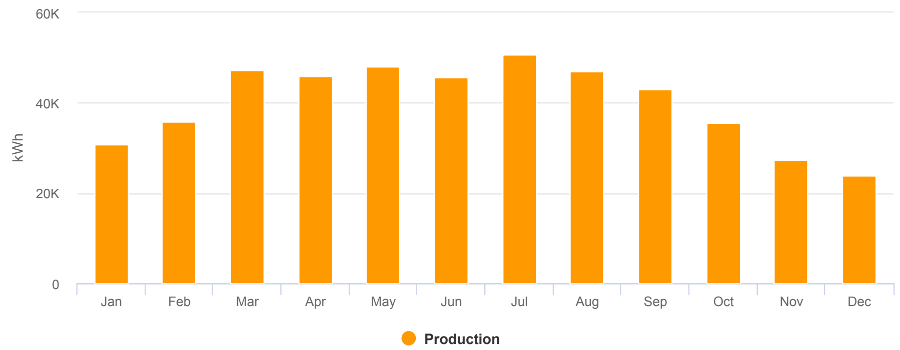
System Metrics

Design	1.7 Dunn Property North Field
Module DC Nameplate	331.2 kW
Inverter AC Nameplate	300.0 kW Load Ratio: 1.10
Annual Production	480.9 MWh
Performance Ratio	85.2%
kWh/kWp	1,452.0
Weather Dataset	TMY, 10km grid (42.85,-70.95), NREL (prospector)
Simulator Version	d423b631b6-68d7c4abe6-363b74c662-adeef4321e

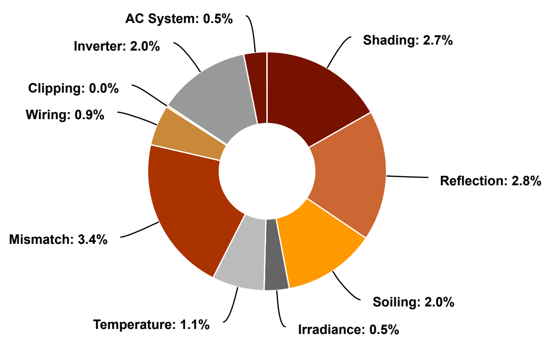
Project Location



Production



System Loss



Annual Production

	Description	Output	% Delta
Irradiance (kWh/m^2)	Annual Global Horizontal Irradiance	1,427.4	-
	POA Irradiance	1,704.7	19.4%
	Shaded Irradiance	1,659.1	-2.7%
	Irradiance After Reflection	1,612.3	-2.8%
	Irradiance After Soiling	1,580.0	-2.0%
	Total Collector Irradiance	**1,579.9**	**-0.0%**
Energy (kWh)	Nameplate	523,766.2	-
	Output at Irradiance Levels	520,939.6	-0.5%
	Output at Cell Temperature Derate	515,053.6	-1.1%
	Output After Mismatch	497,713.1	-3.4%
	Optimal DC Output	493,356.4	-0.9%
	Constrained DC Output	493,169.3	-0.0%
	Inverter Output	483,302.5	-2.0%
	Energy to Grid	**480,886.0**	**-0.5%**

Temperature Metrics

Avg. Operating Ambient Temp	11.9°C
Avg. Operating Cell Temp	20.3°C

Simulation Metrics

Operating Hours	4,669
Solved Hours	4,669
Pending Hours	-
Error Hours	-

Condition Set

Description	Condition Set 1
Weather Dataset	TMY10km grid (42.85,-70.95)NREL(prospector) (download)
Solar Angle Location	Meteo Lat/Lng
Transposition Model	Perez Model
Temperature Model	Sandia Model

Temperature Model Parameters

Rack Type	a	b	Temperature Delta
Fixed Tilt	-3.56	-0.08	3.0°C
Flush Mount	-2.81	-0.05	0.0°C
East-West	-3.56	-0.08	3.0°C
Carport	-3.56	-0.08	3.0°C

Soiling (%)

J	F	M	A	M	J	J	A	S	O	N	D
2	2	2	2	2	2	2	2	2	2	2	2

Irradiation Variance	5.0%
Cell Temperature Spread	4.0°C
Module Binning Range	-2.5% to 2.5%
AC System Derate	0.50%

Component Characterizations

Type	Component	Characterization
Module	LG450S2W-U6 (1000V) (LG)	Spec Sheet Characterization,PAN
Inverter	Sunny Tripower Core1/US (SMA)	Spec Sheet

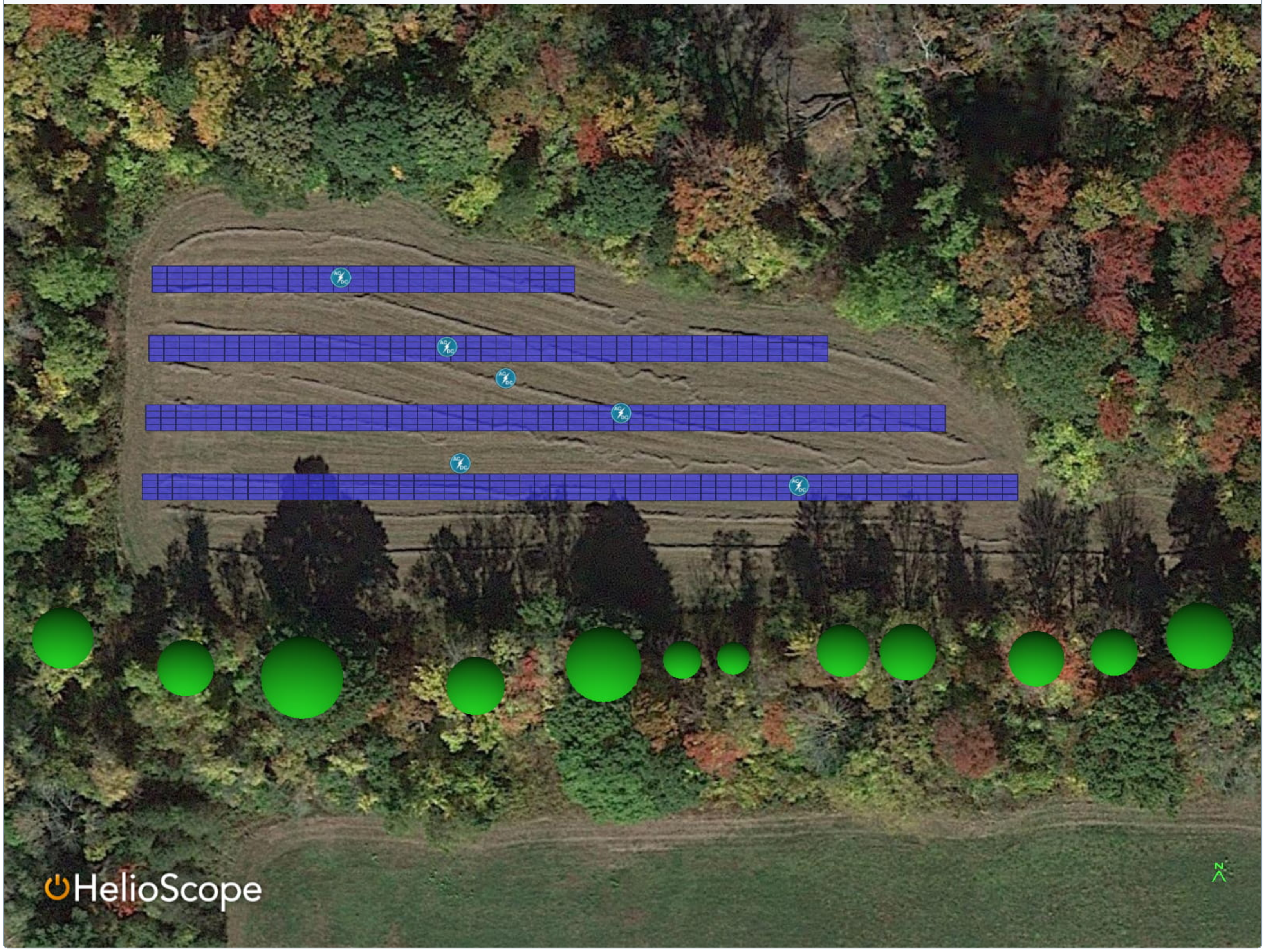
Design BOM

Component	Type	Quantity
3 input Combiners	Combiners	6
5 input Combiners	Combiners	6
12 AWG (Copper)	Home Runs	12
Sunny Tripower Core1/US	Inverters	6
LG450S2W-U6 (1000V)	Modules	736
10 AWG (Copper)	Strings	48

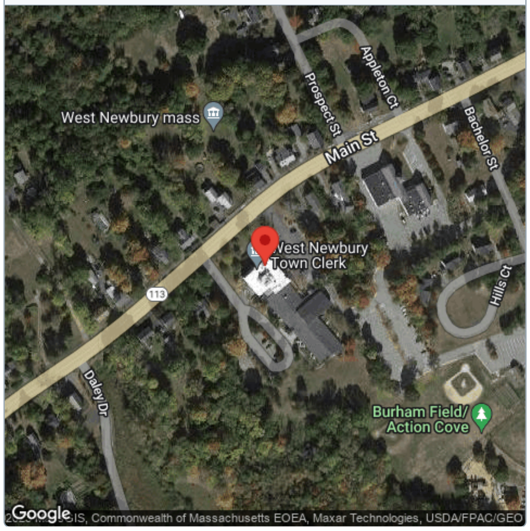
Monthly Shading

Month	GHI (kWh/m^2)	POA (kWh/m^2)	Shaded (kWh/m^2)	Nameplate (kWh)	Grid (kWh)
January	60.4	105.1	101.0	31,882.4	30,813.3
February	81.1	119.6	116.7	36,854.5	35,830.8
March	125.9	160.6	157.1	49,662.1	47,279.1
April	146.3	161.4	157.5	49,754.9	45,883.1
May	169.5	172.3	167.6	52,855.1	47,998.0
June	171.2	167.5	162.5	51,137.6	45,638.1
July	188.3	188.2	183.2	57,788.6	50,835.9
August	160.2	172.7	168.4	53,174.4	46,946.3
September	128.4	155.6	152.2	48,108.3	43,031.1
October	89.4	125.1	122.3	38,691.5	35,488.6
November	60.3	94.8	92.0	29,056.0	27,373.7
December	46.4	81.9	78.5	24,800.7	23,767.9

Design Render



Project Location



Design Wiring Zone

Description	Combiner Poles	String Size	Stringing Strategy
Wiring Zone	12	13 - 17	Along Racking

Field Segments

Description	Racking	Orientation	Tilt	Azimuth	Intrarow Spacing	Frame Size	Frames	Modules	Power
Field Segment 1	Fixed Tilt	Landscape (Horizontal)	30°	180.031°	20.0 ft	4x1	184	736	331.20 kW

1.7 Dunn Property South Field West Newbury 381 Main St, West Newbury, MA 01985, USA

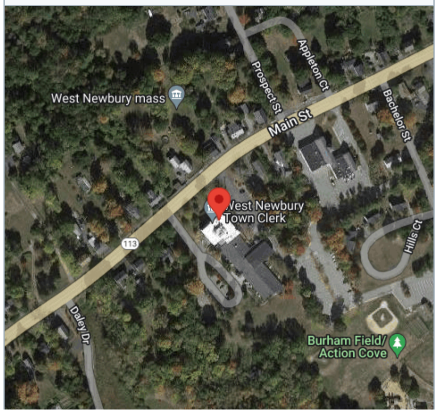
Project Details

Address	381 Main St, West Newbury, MA 01985, USA
Owner	Gabrielle Cole
Last Modified	Gabrielle Cole a few seconds ago
Location	(42.80050330000001, -70.9892665) (GMT -5)
Profile	Default Commercial

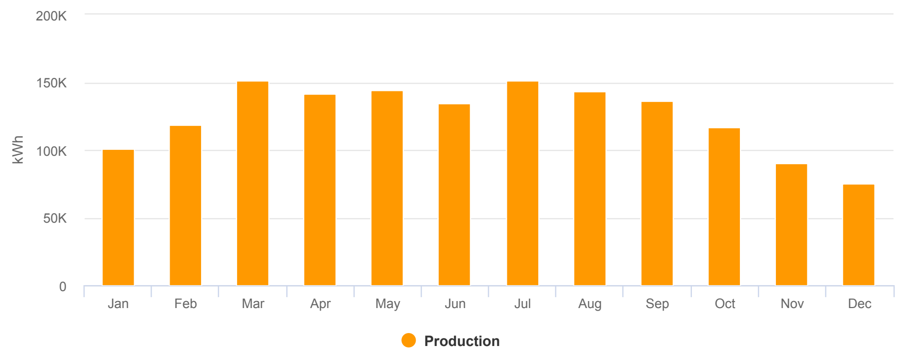
System Metrics

Design	1.7 Dunn Property South Field
Module DC Nameplate	1.1 MW
Inverter AC Nameplate	937.5 kW Load Ratio: 1.13
Annual Production	1.5 GWh
Performance Ratio	82.9%
kWh/kWp	1,425.1
Weather Dataset	TMY, 10km grid (42.85,-70.95), NREL (prospector)
Simulator Version	e0419dc019-dcabad097e-4d5d0f02fa-0e176ffd8f

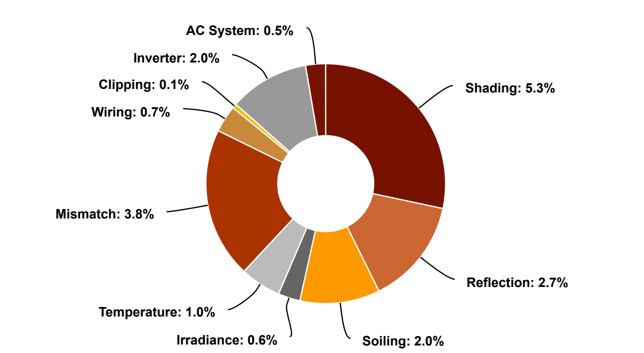
Project Location



Production



System Loss



Annual Production

	Description	Output	% Delta
Irradiance (kWh/m²)	Annual Global Horizontal Irradiance	1,427.4	-
	POA Irradiance	1,719.2	20.4%
	Shaded Irradiance	1,628.9	-5.3%
	Irradiance After Reflection	1,585.5	-2.7%
	Irradiance After Soiling	1,553.8	-2.0%
	Total Collector Irradiance	**1,553.7**	**-0.0%**
Energy (kWh)	Nameplate	1,643,165.4	-
	Output at Irradiance Levels	1,634,074.8	-0.6%
	Output at Cell Temperature Derate	1,617,388.2	-1.0%
	Output After Mismatch	1,556,404.6	-3.8%
	Optimal DC Output	1,545,940.7	-0.7%
	Constrained DC Output	1,544,212.6	-0.1%
	Inverter Output	1,513,295.6	-2.0%
	Energy to Grid	**1,505,729.2**	**-0.5%**

Temperature Metrics

Avg. Operating Ambient Temp	11.9°C
Avg. Operating Cell Temp	20.1°C

Simulation Metrics

Operating Hours	4,669
Solved Hours	4,669
Pending Hours	-
Error Hours	-

Condition Set

Description	Condition Set 1
Weather Dataset	TMY10km grid (42.85,-70.95)NREL(prospector) (download)
Solar Angle Location	Meteo Lat/Lng
Transposition Model	Perez Model
Temperature Model	Sandia Model

Temperature Model Parameters

Rack Type	a	b	Temperature Delta
Fixed Tilt	-3.56	-0.08	3.0°C
Flush Mount	-2.81	-0.05	0.0°C
East-West	-3.56	-0.08	3.0°C
Carport	-3.56	-0.08	3.0°C

Soiling (%)

J	F	M	A	M	J	J	A	S	O	N	D
2	2	2	2	2	2	2	2	2	2	2	2

Irradiation Variance	5.0%
Cell Temperature Spread	4.0°C
Module Binning Range	-2.5% to 2.5%
AC System Derate	0.50%

Component Characterizations

Type	Component	Characterization
Module	LG450S2W-U6 (1000V) (LG)	Spec Sheet Characterization,PAN
Inverter	Sunny Tripower CORE1 62-US (SMA)	Spec Sheet

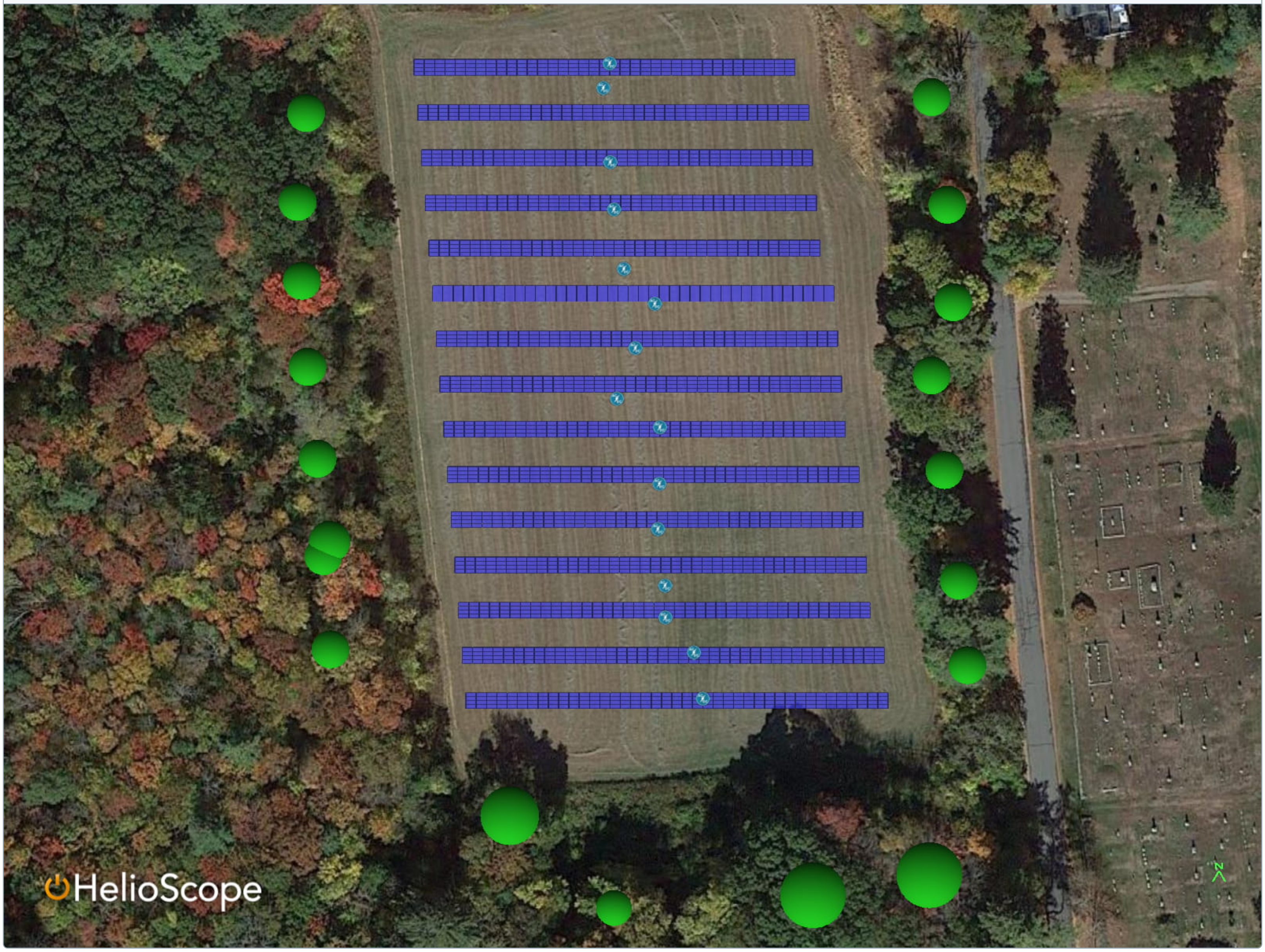
Design BOM

Component	Type	Quantity
3 input Combiners	Combiners	11
4 input Combiners	Combiners	4
6 input Combiners	Combiners	4
7 input Combiners	Combiners	11
12 AWG (Copper)	Home Runs	30
Sunny Tripower CORE1 62-US	Inverters	15
LG450S2W-U6 (1000V)	Modules	2,348
10 AWG (Copper)	Strings	150

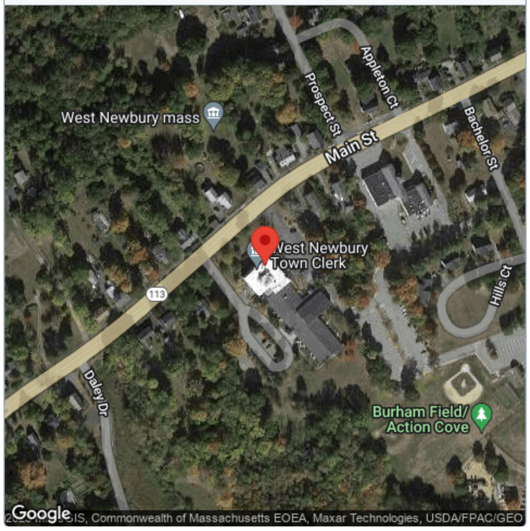
Monthly Shading

Month	GHI (kWh/m^2)	POA (kWh/m^2)	Shaded (kWh/m^2)	Nameplate (kWh)	Grid (kWh)
January	60.4	115.2	104.9	106,339.1	100,804.6
February	81.1	126.9	121.3	122,713.0	118,663.9
March	125.9	164.6	158.4	160,041.4	151,584.9
April	146.3	158.9	152.0	153,184.9	141,378.9
May	169.5	165.5	157.2	158,029.5	143,882.7
June	171.2	159.0	150.4	150,701.0	134,860.6
July	188.3	179.7	170.9	171,554.5	151,436.4
August	160.2	168.9	161.2	162,328.4	143,617.5
September	128.4	157.4	151.2	152,642.4	136,598.9
October	89.4	131.2	126.1	127,721.2	116,864.4
November	60.3	102.0	95.7	97,013.1	90,555.5
December	46.4	90.0	79.8	80,896.8	75,480.8

Design Render



Project Location



Design Wiring Zone

Description	Combiner Poles	String Size	Stringing Strategy
Wiring Zone	12	14 - 17	Along Racking

Field Segments

Description	Racking	Orientation	Tilt	Azimuth	Intrarow Spacing	Frame Size	Frames	Modules	Power
Field Segment 1	Fixed Tilt	Landscape (Horizontal)	40°	180°	20.0 ft	4x1	587	2,348	1.06 MW

Appendix B: Sample Battery Energy Storage System Cut Sheet

DYNAPOWER COMPANY

Trusted Worldwide Since **1963**

MPS®-i-125 EHV

ENERY STORAGE SYSTEM

2, 4 or 6 HOUR SYSTEMS

The **MPS®-i-125 EHV** is a fully integrated behind-the-meter energy storage system that combines Dynapower's efficient UL 1741 SA **MPS®-125 EHV** inverter with Li-Ion batteries in a temperature controlled battery NEMA-rated enclosure. The highly compact integrated system is easily deployed on a concrete pad, crushed stone or on the ground with a forklift and minimal labor, reducing system installation costs for integrators and system owners. The system features Dynapower's propreitary Dynamic Transfer™ which in the event of grid disturbance seamlessly switches a facility from grid-tied to battery backup power. Multiple **MPS®-i-125 EHV** systems can be paralleled together to meet the sizing needs of any behind-the-meter installation.

FEATURES:

+ AC Overcurrent Protection
+ DC Disconnect
+ Integrated DC Input Fuses
+ Redundant HVAC cooling systems
+ Fire Suppression System
+ All AC and DC Switchgear
+ DC Pre-Charge
+ Black Start (Optional)
+ Dynamic Transfer™

DYNAMIC TRANSFER TO OFF GRID MODE

Dynapower's patented Dynamic Transfer™ algorithm monitors grid stability, and upon detecting a grid disturbance, disconnects from the grid. The equipment seamlessly transitions critical loads to stand-alone mode on the load connection and supports 100% phase imbalance in UF mode.

BLACK START

In the event of a complete system power outage, Dynapower's patented Black Start restores power to the facility without the need for external power. Dynapower's Black Start technology can start distribution networks even with transformer magnetizing currents that exceed the power rating of the inverters. Multiple MPS®-i-125 EHV units can be restarted at once.

E COMP: AUTONOMOUS VOLT/VAR SUPPORT

A Volt Var function that provides immediate and automatic voltage support to the grid.

F COMP: AUTONOMOUS Hz/WATT SUPPORT

A Hz-Watt function that provides immediate and automatic frequency support to the grid.

DYNAPOWER

MPS®-i125 EHV ENERGY STORAGE SYSTEM

BATTERY SPECIFICATIONS

Energy Rating	2, 4, and 6 Hour
Power Rating	BTM 125: 125kW @ 480v 150kW @ 600v BTM 250: 250kW @ 480v 300kW @ 600v
Certifications	UL 1973 (Tray), UL 1642

GRID CONNECTION

AC Line Voltage	480-600 V_{AC} 3 Phase
AC Line Nominal Frequency	60 Hz
Continuous AC Current	150 A RMS per MPS Inverter
Overload AC Current	180 A RMS
Continuous AC Power	125 kW (@480) 150 kW (@600)
Power Factor	0 - 1.0 Leading or Lagging
Current Harmonics	IEEE 1547 Compliant, <5% TDD
Roundtrip Efficiency	93%

ENVIRONMENTAL SPECIFICATIONS

Operating Temp	-25 to 50°C, De-rated from 45 to 50°C
Cooling	Forced Air Cooled
Rated Max Elevation	1,000 Meters Full Power; Up to 3,000 Meters With Derating
Enclosure	UL 3R / IP 54 (Outdoor)

ADDITIONAL FEATURES

Faults	AC Over Voltage, AC Under Voltage, AC Under Frequency, AC Over Frequency, AC Overload, Over-temperature, DC Over Voltage, DC Over Current
Standards Compliance	IEEE 1547, UL 1741 SA Listing
Safety Features	Anti-islanding with UL Compliant trip points, Hardware Over Current Protection, Surge Protection

certifications

Intertek

ISO 9001

EXPERIENCE YOU CAN TRUST

Dynapower is a leader in the design and manufacture of four-quadrant bi-directional energy storage inverters. The MPS®, CPS® and MPS®-i product lines are IEEE and UL 1741 SA certified; offer sub-cycle response with zero voltage ride-through; feature a Dynamic Transfer™ function that can be operated in both grid-tied or stand-alone (grid forming) modes. Dynapower inverters and integrated energy storage systems are deployed globally, enabling increased penetration of renewable generation resources on the grid, peak shaving and valuable grid resiliency.

1.802.860.7200

rpratt@dynapower.com

East Coast:
85 Meadowland Drive
South Burlington, Vermont 05403

West Coast:
2913 Whipple Road
Union City, California 94587