Long Island Solar Roadmap
Spatial Analysis Methods

Prepared March 2021

Project description

The Long Island Solar Roadmap, a partnership between The Nature Conservancy and Defenders of Wildlife, aims to advance deployment of mid- to large-scale solar power on Long Island that minimizes environmental impacts, maximizes benefits to the region, and expands access to solar energy, including access by traditionally underserved communities. The Roadmap identified and mapped low-impact areas of opportunity for siting mid- to large-scale solar installations (250 kW DC and larger) on rooftops, parking lots, and other land already impacted by development. The analysis indicates that there is potential on Long Island to host enough solar capacity to power more than 4.8 million homes. The Roadmap includes strategies and actions for accelerating low-impact solar development. Visit solarroadmap.org to access the report, summary reports and maps for each town and city in Long Island, and to view the interactive web map where you can explore low-impact sites for solar across Long Island.

This document summarizes the methodology used to perform the spatial analysis for the Roadmap. For inquiries about this analysis, please contact Karen Leu, GIS Specialist at The Nature Conservancy at karen.leu@tnc.org.

Spatial Analysis Overview

The goals of the spatial analysis were to identify low-impact sites for potential solar energy development based on suitability criteria informed by the consortium; characterize the potential solar energy capacity that could be installed on low-impact sites; and provide information on where changes to land use policies and grid modifications may be needed in order to enable additional solar energy development.

The spatial analysis was focused on identifying low-impact areas that can support three types of solar technologies: rooftop, parking lot, and ground-mounted installations. To be considered low-impact, a site must meet a suite of suitability criteria developed in collaboration with the Roadmap's stakeholder consortium, a diverse group of individuals representing state, local, and county government; the solar industry; farmers and farm advocacy organizations; environmental and community organizations; the electric utility; businesses; and academic institutions. Using these criteria developed by the consortium, the spatial analysis identifies sites with enough low-impact area to host a minimum combined solar installation capacity of 250 kW or larger on rooftops, parking lots, and previously impacted lands (Figure 1).

We used tax parcel boundaries to define individual sites. These data were provided through data licenses from Nassau County Department of Information Technology and Suffolk County Real

Property Tax Services Agency. We estimated potential solar installation capacity on suitable sites based on the available installation areas for each type of solar technology—i.e., rooftop area for rooftop solar; parking lot area for parking lot solar; and area of non-forested, previously-altered lands for ground-mounted solar.

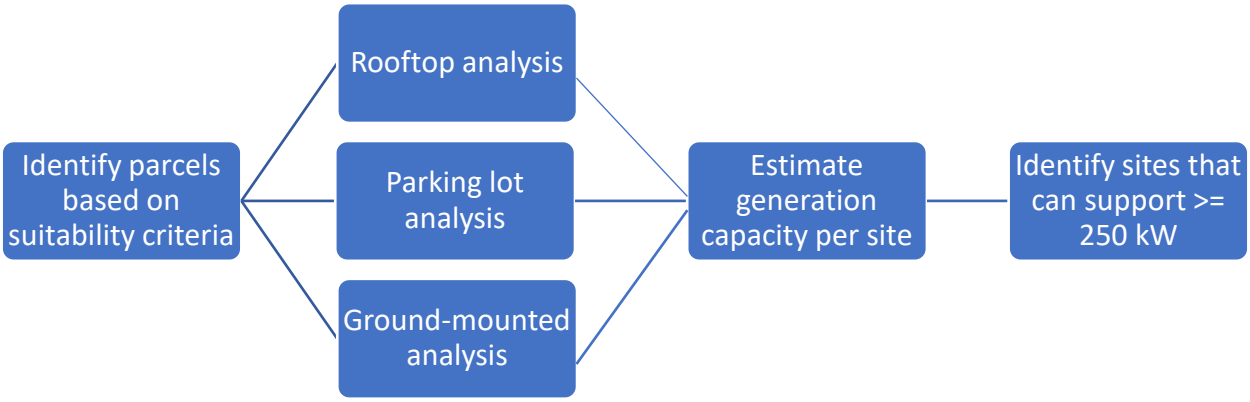

Figure 1. Graphical overview of the Long Island Solar Roadmap spatial analysis.

Suitability Criteria

The consortium developed a set of criteria defining whether a site would be suitable for low-impact solar development. Criteria are based on ecological attributes, land use, and land cover characteristics (Table 1).

Table 1. Factors used to determine site suitability criteria for solar installations.

Ecological attributes	**Wetlands and hydrological features.** Areas within 300 feet of freshwater or tidal wetlands or waterbodies are suitable only for solar installations on existing parking lots and rooftops, not ground-mounted installations.
	Sensitive natural areas. Areas where sensitive natural communities or wildlife species are present are not considered suitable for any kind of solar installation.
	Flood zones. Areas within the 100-year floodplain are suitable only for solar installations on existing parking lots and rooftops, not ground-mounted installations.

	Contaminated areas. Active or not-yet-remediated brownfields and Superfund sites are not suitable for any kind of solar installation. Any contaminated areas that have been fully remediated are suitable for all types of solar installations.
Land use	**Residential areas.** Areas that are classified as residential are not considered suitable for mid- to large-scale solar installations and are excluded from the analysis.
	Protected open spaces. Areas protected for ecological conservation, recreation, or open space are suitable only for solar installations on existing parking lots and rooftops, not ground-mounted installations.
	Agricultural land. All agricultural areas are suitable for solar installations on existing parking lots and rooftops. Ground-mounted installations are considered suitable in areas with compatible land cover (see below) only on farms that are not enrolled in any farmland preservation program. Areas in various farmland preservation programs at the state, county, town, and nonprofit level are not suitable for ground-mounted solar installations.
	Areas of historic or cultural significance. Areas officially designated for historic preservation are not suitable for any kind of solar installation.
Land cover	**Compatible land cover types.** Areas of unforested, sparsely vegetated, and grassy land cover, as well as areas of exposed soil, are considered suitable for ground-mounted solar. Areas with established vegetation, including grassland and forest cover, are not considered suitable.

Parcel Aggregation

Properties and infrastructure belonging to one entity can span across multiple tax parcels (Figure 2). Therefore, using each tax parcel as-is to represent an individual site can potentially restrict the analysis results, as a smaller site is less likely to contain the amount of installation area needed to meet the 250 kW per site threshold. To account for this, we merged adjacent parcels that had the same ownership type and shared a boundary, creating an aggregated parcel dataset with which to conduct the analysis. This process was undertaken for the property types listed in Table 2.

We used a series of conditional statements to classify each parcel as one of the following ownership type categories based on keywords in the owner info of the source data. Parcels that did not match any of the keyword queries were classified with the ownership type category “Other” and were *not* aggregated with any other parcel.

Figure 2. Two examples showing how adjacent parcels with the same ownership type were aggregated. County tax parcel boundaries (orange) are overlaid on aerial imagery. A single parking lot spanning across multiple parcels shown in A) was aggregated to be considered one site as shown in B) instead of three smaller sites. In another example, a school campus consisting of two parcels shown in C) was aggregated to be considered one site as shown in D).

Table 2. Ownership types assigned to each parcel and example keywords that were used to query them in the dataset.

Ownership Type	**Example Keywords**
Federal	“United States Government”; “U S A”; “Fire Island National”
State	“New York State”; “State of New York”; “State Park”
County	“County of Suffolk”; “Suffolk County”
Town/City/Village	“Town of Huntington”; “Huntington Town”; “Village of Huntington”

Land Trust	“Land Alliance”; “Land Trust”; “Open Space”; “The Nature Conservancy”
School	“Board of Ed”; “School”
College	“College”; “University”
Cemetery	“Cemetery”

In addition to the keyword queries, the following ownership types were classified using New York State property codes[1] for parcels that had them:

- “School” = 612 (Nassau County only)
- “College” = 613 (Nassau County only)
- “Military” = 661

Suitability Analyses

We conducted a series of suitability analyses to remove parcels based on land use, sensitive ecological and environmental areas, protected open spaces, and protected farmland. We also conducted an intra-parcel suitability analysis that further removed parts of parcels in sensitive ecological and environmental areas, flood zones, or were within culturally and historically important sites.

Land Use

County level land use classifications[2] were crucial for understanding landscape-scale patterns of distribution of low-impact sites. The Long Island Solar Roadmap is focused on identifying opportunities to support large-scale solar on non-residential lands. All parcels classified as residential were thus removed from the analysis. Multi-family rental units, like condominiums and apartment complexes, were typically classified as commercial land use rather than residential and remained in the analysis. Additionally, underwater and surface waters were also removed from analysis.

Transportation parcels were initially considered for exclusion, as roadways are not desirable solar installation sites. However, some transportation parcels also included buildings and large rights-of-way areas which were desirable for inclusion in the analysis. Therefore, transportation parcels were included in the preliminary parcel selection and were later selectively removed based on shape

[1] *Property Type Classification Codes*, New York State Department of Taxation and Finance, <tax.ny.gov/research/property/assess/manuals/prclas.htm>.

[2] Nassau County land use classifications were identified from county-provided GIS parcel data. Suffolk County land use classifications can be found in *2016 Land Use–Suffolk County*, Suffolk County Department of Planning, 2018, <suffolkcountyny.gov/Portals/0/formsdocs/planning/Publications/2016%20Land%20Use%20-%20Suffolk%20County.pdf?ver=2019-04-15-162352-000>.

geometry metrics (i.e., linear features representing roadways were removed, while wider features were retained).

Nassau and Suffolk Counties each use slightly differing land use category names and definitions. We generalized these classifications into broader categories for each county to make results more interpretable in the town/city summary sheets (Tables 3 and 4). Though similarly named categories may be used as a proxy for comparison across the region, we do not recommend directly comparing results from each county based on land use categorizations. For example, recreational lands, wild conservation lands, and public parks in Nassau County may not describe the exact same type of land as recreational lands and open space in Suffolk County.

Table 3. Nassau County land use classifications, and the condensed categories used in the spatial analysis results.

Nassau County Land Use Classification	**Spatial Analysis Land Use Name**
Agriculture	Agricultural
Commercial	Commercial & industrial
Industrial	
Community services	Community services & public services
Public Services	
Recreation and entertainment	Recreational lands, wild conservation lands, and public parks
Wild, conservation lands, and public parks	
Residential*	Residential*
Vacant land	Vacant land
None**	Unknown
* Removed from analysis. ** Parcels with missing land use classification were assigned this category.	

Table 4. Suffolk County land use classifications, and the condensed categories used in the spatial analysis results.

Suffolk County Land Use Classification	**Spatial Analysis Land Use Name**
Agriculture	Agricultural
Commercial	Commercial / industrial
Industrial	

Institutional	Institutional
Recreation and open space	Recreational lands and open space
Low Density Residential; Medium Density Residential; High Density Residential*	Residential*
Surface waters*	Surface waters*
Transportation	Transportation
Utilities	Other
Vacant	
Waste handling and management	
None**	
* Removed from analysis. ** Parcels with missing land use classification were assigned this category.	

Sensitive Ecological and Environmental Areas

To ensure that ecologically sensitive areas are protected, we referenced datasets from New York Natural Heritage Program. Parcels with centroids that intersected sensitive ecological communities or the habitat ranges of vulnerable, imperiled, or critically imperiled species were removed from the analysis. Parcels within the protected Pine Barrens Core Area boundary in Suffolk County were also removed. Similarly, active brownfields and Superfund sites and sites currently undergoing remediation were removed. Fully remediated brownfields and Superfund sites were considered suitable for development of all solar technologies.

Protected Open Spaces

Areas defined as protected open space were considered unsuitable for ground-mounted solar installations, while existing rooftops and parking lots in these areas were suitable for solar installations. To identify protected open spaces, we queried county tax parcels that met two criteria: 1) had a land use classification of “recreation and open space” for Suffolk County or “wild, conservation lands, and public parks or recreational lands” for Nassau County, and 2) were owned by a public entity, land trust, cemetery, or school[3]. We also included parcels in the Suffolk County Proposed Open Space Acquisition List[4] and the Nassau County Public Open Spaces web map[5] as protected open spaces.

[3] Based on parcel ownership analysis described in the “Parcel Aggregation” section.
[4] *Comprehensive Master List Update 2012 – Proposed Open Space Acquisitions*, Suffolk County Department of Economic Development & Planning, <suffolkcountyny.gov/portals/0/formsdocs/planning/OpenSpaceFarmland/OpenSpace/CMLU12_FINAL.pdf>.
[5] *Nassau County Public Open Spaces,* Nassau County Parks, <arcgis.com/apps/MapJournal/index.html?appid=76473c9be39146929e95c6f6d9833508>.

Protected Farmland

Protected agricultural lands were considered unsuitable for ground-mounted solar, while existing rooftops and parking lots on farmland were suitable for solar installations. We referenced a list of protected Suffolk County farmlands[6] for parcels to apply these restrictions to. Very few agricultural parcels were identified for Nassau County, and none were considered protected farmland.

While we did not consider soil types in the analysis, the web tool includes an overlay describing important agricultural soils. American Farmland Trust has created a nationwide data layer characterizing productivity, versatility, and resiliency of agricultural soils.[7] We clipped this layer to our study area and provide it as an overlay on the web tool that can be visually compared to Roadmap results.

Intra-parcel Suitability Analysis

In addition to assessing suitability of entire parcels, we examined areas within parcels for compatibility with low-impact solar development. Specific areas were spatially defined and coded based on which solar technologies were suitable for installation.

Sensitive ecological and environmental areas, considered unsuitable for any solar development, were further removed from areas not already included in the previous step that removed parcels whose centroids intersected those areas.

Culturally and historically significant areas were considered unsuitable for ground-mount solar. Existing rooftops and parking lots on these sites were considered suitable for solar installations. We used the National Register of Historic Places and NYS Historic Sites and Park Boundaries to identify sites including state parks, state historic sites, and conservation easements to be restricted in this way.

The 100-year flood zone as defined by the Federal Emergency Management Agency (FEMA) was used to designate areas unsuitable for any ground-mounted solar. Existing rooftops and parking lots within the 100-year flood zone were considered suitable for solar installations.

Hydrographic features, including streams, rivers, and lakes, and tidal and freshwater wetlands were considered sensitive ecological areas and unsuitable for installations of ground-mounted and parking lot solar. Installations on existing rooftops were deemed suitable. New York law states that construction cannot take place within 300 ft of a tidal wetland without a permit[8]. We interpreted that any new construction within this distance could not be considered low-impact and applied this buffer to freshwater wetlands and other hydrography features as well; the resultant zones were designated unsuitable for ground-mounted and parking lot solar.

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[6] *Suffolk County Agriculture & Farmland Protection Plan – 2015*, Department of Economic Development & Planning, 2018, <suffolkcountyny.gov/Portals/0/formsdocs/planning/Publications/2016%20Land%20Use%20-%20Suffolk%20County.pdf?ver=2019-04-15-162352-000>.

[7] *Farms Under Threat: The State of the States,* American Farmland Trust, <csp-fut.appspot.com>.

[8] NYCRR Title 6 § 661.

Solar Installation Areas

The spatial analysis examined potential generation capacity for three types of solar arrays—rooftop, parking lot, and ground-mounted installations. We developed separate spatial layers showing the low-impact areas available for each solar installation type. Overlapping features between these layers were clipped and removed to ensure that installation opportunities were not double-counted (e.g. the overlap of a building and a parking lot feature would be removed to ensure only one of the features existed in that space). Typically, the hierarchy used for this cleanup was to prioritize rooftops, then parking lots, and finally areas for ground-mounted solar, except where visual inspection determined otherwise. Each layer was then overlaid with the intra-parcel suitability layer to create potential installation areas specific to each solar installation type. Finally, we summarized the total low-impact installation areas within each parcel in ArcGIS.

We acknowledge that estimates of low-impact installation areas and therefore potential installation capacity (described below) are likely overestimates due to the assumptions inherent in spatial datasets and the methods described. Estimates of available rooftop area were based on building footprints and did not account for the setbacks required for solar array installation. Solar carports in parking lots must consider driveways and medians between structures, which could not be accounted for in the data. Estimates of land cover suitable for ground-mounted solar were based on automated image classification that contains inherent uncertainties due to spatiotemporal and technical constraints. While we acknowledge these limitations, we opted to err on the side of including more sites as suitable for low-impact solar rather than missing potential opportunities.

Rooftops

We used a nationwide dataset of building footprints[9] to estimate the area available for rooftop solar. The dataset was comprehensive and represented a consistent methodology for the Long Island region. We manually identified and removed large expanses of greenhouses present in the building footprint layer by intersecting the layer with agricultural parcels. The dataset was otherwise used as-is.

Parking Lots

For Nassau County, we used a planimetric parking lots dataset provided by Nassau County Department of Information Technology (1992). We determined that this dataset adequately represented present day parking lots for the purposes of this analysis, in no small part because of how densely developed Nassau County already is.

For Suffolk County, existing comprehensive parking lot data could not be obtained. In partnership with the GIS departments of the Town of Huntington and Town of Southampton, we digitized parking lots for Suffolk County. Because digitization was conducted by multiple participants, some variation in spatial accuracy exists in the dataset between towns. Generally, parking lots are defined as paved areas with the primary function of vehicle parking. Some notable exclusions to the parking lot

[9] *US Building Footprints,* Microsoft, <github.com/Microsoft/USBuildingFootprints>.

dataset include boat storage, junkyards or non-vehicle storage, and storage of oversized equipment such as construction vehicles.

Ground-mounted

Low-impact areas suitable for ground-mounted solar arrays were unforested, sparsely vegetated sites. We used automated image classification using Google Earth Engine on recent, high-resolution aerial imagery[10] to identify suitable land cover for ground-mounted solar installations. The classification segmented the imagery into land cover types of forest, water, impervious surfaces, grass, and barren lands—the latter two categories were extracted as suitable areas for ground-mounted solar installations. Areas occupied by building footprints and parking lots were removed to ensure no double-counting of suitable area. Fragments and slivers in the dataset were removed based on area and area-to-shape-index ratio. We did not take into consideration the slope of the land, an important factor along with other metrics necessary to determine solar feasibility.

Installation Capacity Calculations

For each type of solar installation, we calculated potential installation capacity within a site by multiplying its available area by its estimated panel density. Estimates of panel density, or installed capacity per unit area, were based on previous solar siting surveys[11] [12] [13] and validated by consortium members (Table 5). High-medium-low panel density was defined as 8-7-6 watts per square foot (W/ft^2). Clean Coalition asserts that these numbers were conservative to provide an additional downward margin and avoid over-estimation. We used high (8 W/ft^2) and low densities (6 W/ft^2) to estimate a range of potential installation capacities for rooftop arrays to account for differences in rooftop configuration and the presence of equipment, such as heating, ventilation, and air conditioning (HVAC) units and ductwork, exhaust ventilation fans, service walkways, and other installations. We assume ground-mounted panels are installed at a high density of 8 W/ft^2, and panels in parking lot arrays are installed at a medium density of 7 W/ft^2.

Table 5. Estimates of installed capacity per unit area (panel density) for solar array types.

Solar array type	Panel density
Rooftop	6–8 W/ft^2

[10] Image classification was conducted in Google Earth Engine using Sentinel-2 imagery from May 1, 2017 to October 1, 2018 and Sentinel-1 imagery from May 1, 2018 to July 30, 2018.

[11] *East Bay Community Energy Solar Siting Survey, Draft Final Summary Report: Solar Photovoltaic (PV) Commercial-Scale Sites for 1,000 kW (AC) and Larger*, Clean Coalition, 2017, <clean-coalition.org/wp-content/uploads/2018/11/Task-1-EBCE-Solar-Siting-Survey-summary-report_DRAFT.pdf>.
[12] *Peninsula Advanced Energy Community (PAEC) Task 8: Solar Siting Survey Summary Final Report of Commercial-Scale Sites for 100 kW (AC) or Larger Solar Photovoltaic (PV),* Clean Coalition, 2017, <clean-coalition.org/wp-content/uploads/2018/11/PAEC-Solar-Siting-Survey-Summary-32_jv-6-Apr-2017.pdf>.
[13] *Diego Solar Siting Survey, Task 2.2 Final Summary Report: Solar Photovoltaic (PV) Commercial-Scale Sites for 1,000 kW AC and Larger,* Clean Coalition, 2018.

Parking lot	7 W/ft^2
Ground-mounted	8 W/ft^2

Final Site Selection

We identified suitable sites in that had a total generation capacity of at least 250 kW in any combination of potential rooftop, parking lot, and ground-mounted arrays. This would become the final layer of low-impact sites for mid- to large-scale solar in Nassau and Suffolk Counties.

GIS Data Sources

Dataset	**Date**	**Source**
Nassau County parcels	2018	Nassau County Department of Information Technology
Suffolk County parcels	2018	Suffolk County Real Property Tax Service Agency
Element Occurrence Communities and Species Ranges	2019	New York Natural Heritage Program
Environmental Remediation sites	2013	NYS Department of Environmental Conservation
New York Protected Areas Database (NYPAD)	2017	New York Natural Heritage Program
Nassau County Public Open Spaces	2018	Nassau County Parks
NYS Historic Sites and Park Boundaries	2018	NYS Office of Parks, Recreation, and Historic Preservation, NYS Historic Preservation Office
National Register of Historic Places in New York State	2018	NYS Office of Parks, Recreation, and Historic Preservation, NYS Historic Preservation Office
Digital Flood Insurance Rate Maps (DFIRM)	2009	Federal Emergency Management Agency
National Hydrography Dataset	2016	US Geological Survey
Freshwater Wetlands	2002	NYS Department of Environmental Conservation
National Wetlands Inventory	2004/2008	US Fish & Wildlife

U.S. Building Footprints	2018	Microsoft
Nassau County Planimetric Parking Lots	1992	Nassau County Department of Information Technology
Suffolk County Parking Lots	2016	Town of Southampton; Town of Huntington; The Nature Conservancy