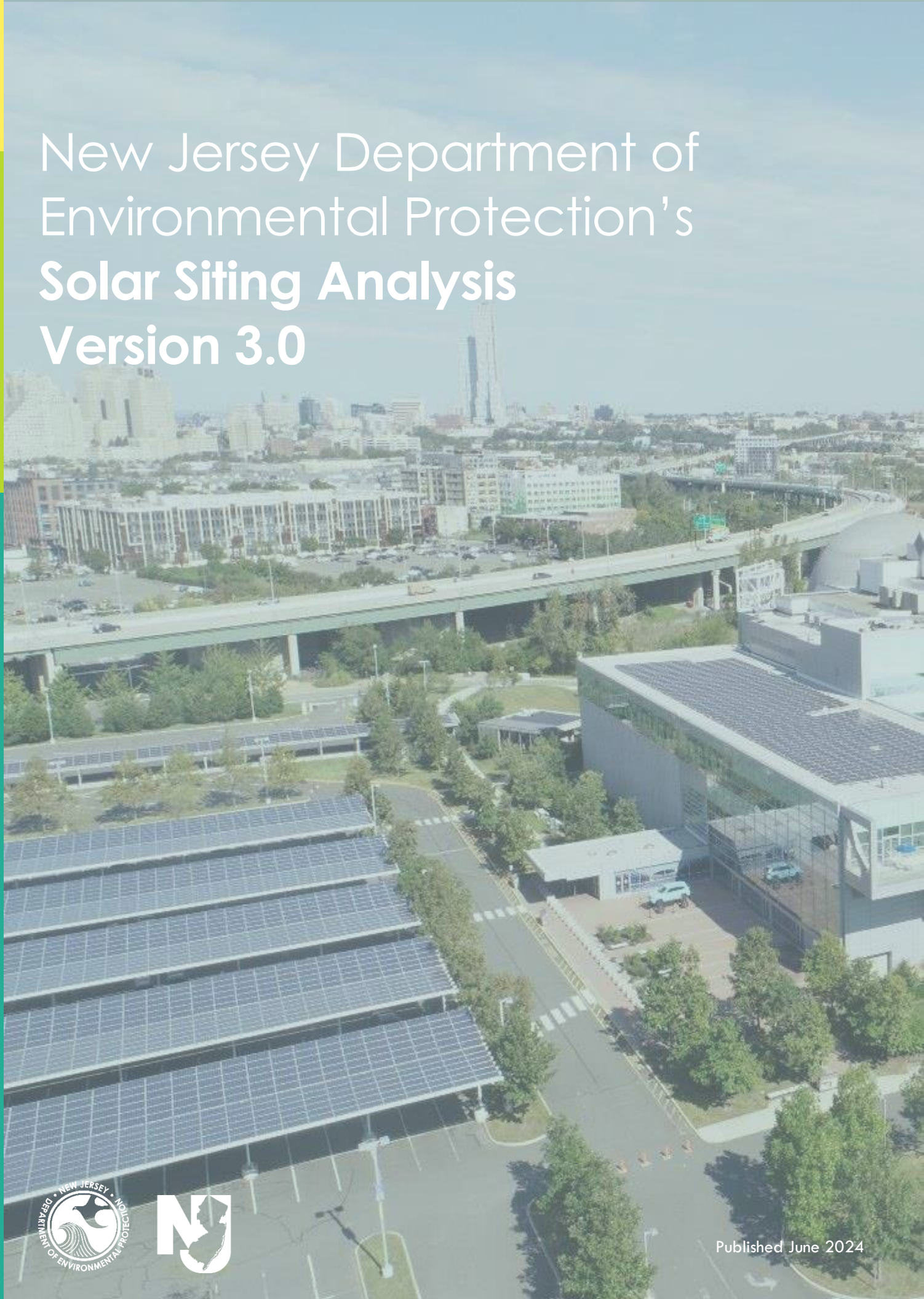
New Jersey Department of Environmental Protection's **Solar Siting Analysis Version 3.0**



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EXECUTIVE SUMMARY

Solar photovoltaic (PV) systems continue to play a key role in helping New Jersey achieve the clean energy goals outlined in the 2019 Energy Master Plan (NJBPU, 2019), the Global Warming Response Act 80x50 Report (NJDEP, 2020), as well as the State's Renewable Portfolio Standard (RPS) mandates. The EMP set forth a goal of obtaining 100% clean energy by 2050 - which would require roughly 32 gigawatts (GW) of installed solar capacity. In order to support this ambitious build out of 27 GW of new solar PV, upwards of 135,000 acres[1] of land, rooftop and other areas will need to be dedicated to solar panels and their associated infrastructure over the next three decades. As such, it is critical that future solar projects are properly sited to ensure the protection of open space, natural lands, and the critical habitats and ecosystems that can be found throughout the Garden State.

To guide the environmentally responsible siting of this exponential growth in solar PV systems, the Department is releasing a new solar siting analysis. The Solar Siting Analysis Version 3.0 (SSA v3.0) builds upon the groundwork of the 2017 Solar Siting Analysis Update (NJDEP, 2017) and incorporates 20 unique GIS datasets – all of which have an environmental relevance to solar siting – to determine the solar siting preference based on a cumulative range of values, or scores; differing from the previous version which only included a single data set (land use/land cover). Doing so enables the SSA v3.0 to provide a more robust and refined indicator of the Department's solar siting preference with a goal of fostering solar PV development in an environmentally responsible manner.

A summary of the results of the analysis can be seen in Table ES.1. Tiers were established based on ranges of scores and similarities between the types of locations that may fall into each Siting Tier. Generally speaking, Tiers 1 and 2 are seen as the most preferred locations for siting solar PV, accounting for more than 500,000 acres of land that are likely to be urban or developed lands (impervious surfaces and rooftops included) and may contain site contamination that could benefit from redevelopment in the form of clean energy. Siting solar PV in lands classified within these two upper echelon Siting Tiers is most preferred from an environmental standpoint, because doing so may result in limited, or no, environmental disturbance. Tiers 3, 4 and 5 are generally seen as moderately preferred lands and can vary in site type from miscellaneous urban lands to lower priority natural lands and agricultural lands. While nearly 2 million acres of the State have been classified within these Tiers, some lands may be better suited from an environmental perspective for siting solar. The bottom two Tiers, 6 and 7, represent the least preferred lands for siting solar PV in the State, accounting for roughly 2.6 million acres of natural lands. Siting solar PV in these areas would

Table ES.1: Acreage by Solar Siting Tier and NJDEP preference.

	Siting Tier	Score	Acreage	Percentage
Most Preferred	Tier 1	50+	174,781.45	3.5%
	Tier 2	45	1,379.47	6.7%
		40	3,198.81	
		35	2,651.46	
		30	323,736.44	
Moderately Preferred	Tier 3	25	9,360.64	0.5%
		20	8,633.74	
		15	7,521.82	
	Tier 4	10	51,267.49	23.2%
		5	553,817.86	
		0	189,724.54	
		-5	190,248.64	
		-10	168,518.93	
	Tier 5	-15	103,743.08	14.8%
		-20	270,621.18	
		-25	362,113.53	
Least Preferred	Tier 6	-30	329,064.18	23.3%
		-35	320,964.57	
		-40	271,556.82	
		-45	234,806.68	
	Tier 7	-50+	1,392,017.12	28.0%
	TOTAL		**4,969,728.44**	**100.0%**

[1] Assuming the current efficiencies of existing Solar PV technologies and comparing size-to-capacity ratio of existing projects in the State. On average, solar projects in the State have required from 3 to 5 acres of land needed for every 1 MW of installed solar capacity. The value of 135,000 acres was calculated based on the approximate 27 GW of solar needed, assuming the upper range of 5 acres needed per MW.

likely cause significant environmental disturbance and have the potential to impact critical habitats and valuable ecosystem services and should therefore be avoided. Meeting the solar goals of the EMP would consume less than 8% of the total acreage in Siting Tiers 1 through 4.

It is important to note that, as was the case with the 2017 Solar Siting Analysis Update and its associated GIS mapping application, the products of the Solar Siting Analysis Version 3.0 are intended to be utilized as screening tools to evaluate land for environmentally responsible siting of solar PV projects. These tools are not meant to indicate whether a proposed solar project would be allowed – rather they may be used to inform stakeholders of the Department's siting preference. Potential solar PV projects should be evaluated and assessed on a site-by-site basis, and, where necessary, obtain the appropriate permits and approvals. The Solar Siting Analysis v3.0 is the third version of this tool since its initial development in 2012. The Department plans to continue to update this tool over time, as needed, to account for changes in the solar market, technologies, and as updates to each of the component data layers used for the analysis are published.

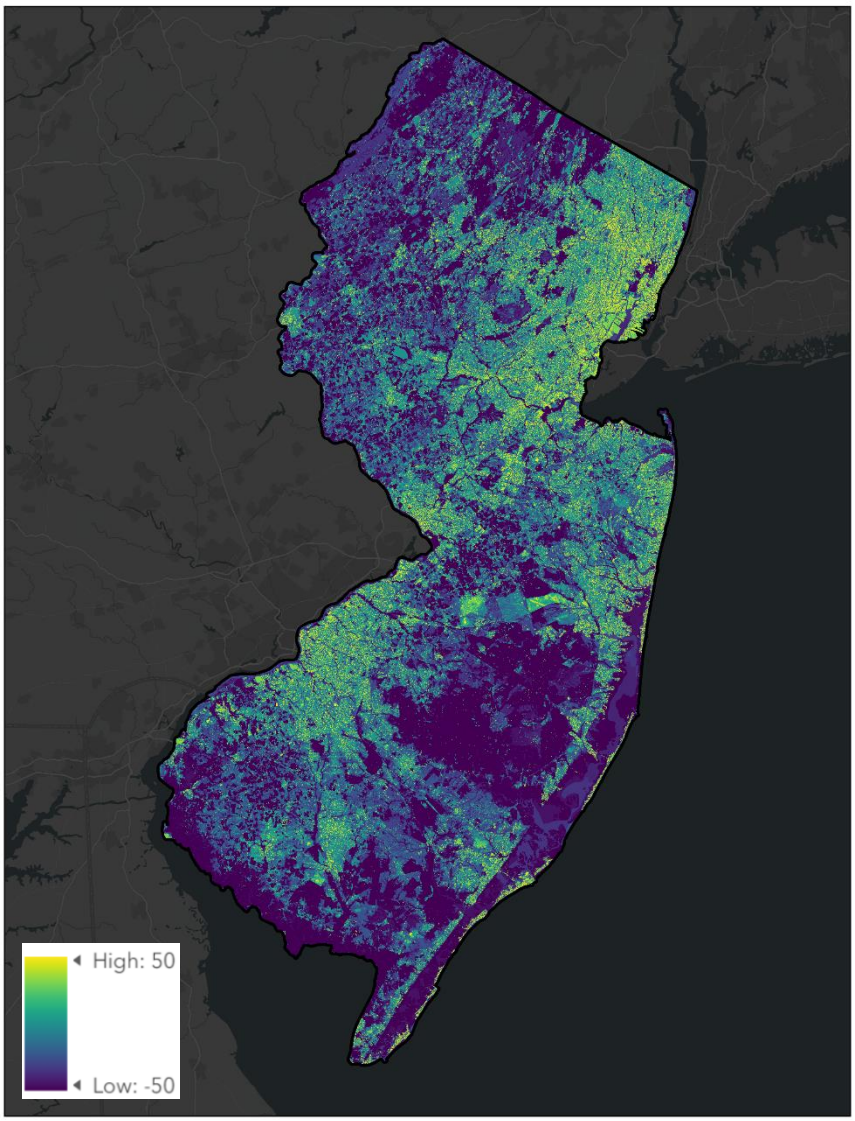


Figure ES.1. Solar Siting Analysis Version 3.0 Statewide Raster. Brighter colors (yellows and greens) symbolize higher siting scores, while the darker colors (blues and purples) indicate lower siting scores. High scores indicate DEP's preference for siting solar at these locations when compared to areas with lower scores.

INTRODUCTION

In May 2018, Governor Murphy's Executive Order No. 28 directed the New Jersey Board of Public Utilities (BPU), in partnership with other state agencies, to develop a statewide clean energy plan to shift away from energy production that contributes to climate change. In 2020, two foundational documents were released to guide State action. The 2019 Energy Master Plan (NJBPU, 2019) and the Global Warming Response Act 80x50 Report (NJDEP, 2020) collectively outlined a series of emission reduction pathways and policy recommendations to achieve the twin goals of 100 percent clean energy and an 80 percent reduction in greenhouse gas emissions by 2050. The timing for achieving these goals was accelerated in February 2023 through Governor Murphy's Executive Order No. 315, which set the new target date for 100% clean energy (meaning 100% of the electricity sold in the State coming from clean sources of electricity) by the end of 2035.

One of the primary strategies to achieving these goals is the installation of upwards of 32 gigawatts (GW) of solar electric generating capacity by 2050 (Figure 1). As New Jersey sets out to achieve this solar build out, it must do so in an environmentally responsible manner — emphasizing the need to prioritize siting future solar PV arrays on the built environment and other preferential lands such as contaminated sites and landfills whenever possible.

The New Jersey Department of Environmental Protection's (Department) Solar Siting Analysis serves as a policy document for providing State and local agencies, as well as solar developers, with guidance indicating lands where the Department encourages solar development and those where the Department discourages solar development. The original Solar Siting Analysis was published in 2012, shortly after the Solar Act of 2012 was passed into law, and was last updated in late 2017. This latest revision, the SSA v3.0, incorporates 20 different environmental geo-spatial data layers to generate a more robust solar siting score that indicates siting preference statewide. This document, and any supplementary mapping tools, are intended to be used as guidance along with legislation, regulations, and other tools to assist in optimizing the siting of solar energy projects necessary to meet New Jersey's clean energy goals identified above.

SOLAR PV IN NEW JERSEY

In the years since the publication of the previous Solar Siting Analysis (2017), solar energy in New Jersey has continued to grow as a significant component of the State's clean energy portfolio, more than doubling the total in-State installed capacity over this period. As of April 30, 2024, New Jersey has almost five gigawatts (GW) of installed solar capacity from nearly 200,000 individual solar projects (NJBPU, 2024) (Table 1). Despite its smaller geographic footprint, the State has continued to rank among the top ten states with regards to installed solar capacity, behind much larger states like California, Texas, Florida, North Carolina, Arizona, Nevada, Georgia, New York, and Massachusetts. On a square mile basis, New Jersey is ranked second, with an impressive 0.66 megawatts (MW) of installed solar per square mile (see Appendix I for each State's statistics).

Table 1: Breakdown of Total Solar Installations by Sector (April 30, 2024)

Sector	# Of Projects	Installed Capacity (kw)	% Of Total Capacity
Behind the Meter Residential	189,475	1,621,707	**33%**
Behind the Meter Non-Residential	9,353	2,263,607	**47%**
Grid Supply	191	815,013	**17%**
Community Solar	96	146,908	**3%**
Total	**199,115**	**4,847,235**	**100%**

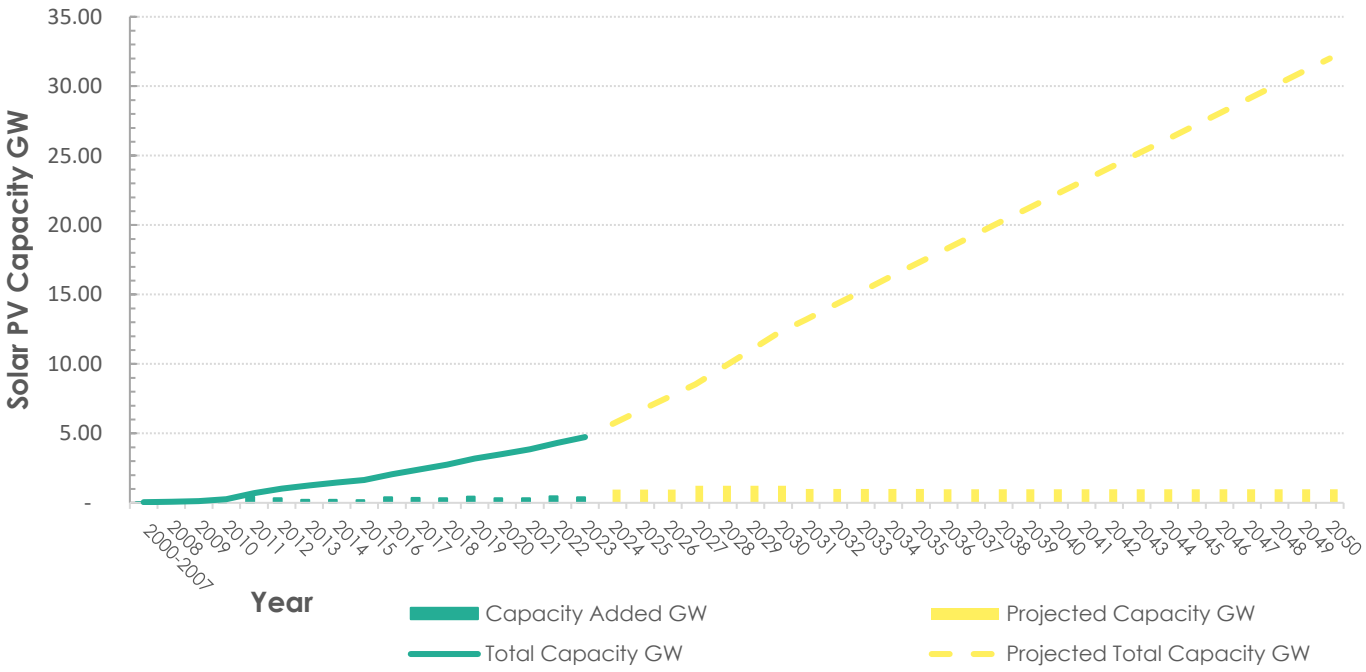


Figure 1: Total Installed and Projected Solar PV to achieve Energy Master Plan goals.

Behind the meter solar projects are typically smaller projects that primarily serve the onsite demand at the location of the solar panels and may send excess energy generated into the grid.

Grid supply solar projects are typically much larger in scale and send electricity generated directly into the grid where it can be utilized elsewhere throughout the State.

The majority of solar projects installed in New Jersey to date are attributed to the behind the meter residential sector, accounting for nearly 95% of all installations (see Figure 2). Despite the high number of projects in this category, the residential sector only accounts for 33% of the total installed capacity in the State, since projects are much smaller to accommodate a residential energy demand.

By contrast, a mere 191 grid supply project installations account for 17% of the total installed capacity in the State due to the larger scale of those projects. An average residential rooftop solar installation of 5 kilowatts (kW) is significantly smaller in size when compared to most grid supply installations, which in New Jersey range from 2 MW to nearly 30 MW. While grid supply projects do benefit from economies of scale from a cost and construction perspective, they require significantly more land area, and are primarily ground mounted, which can incur more environmental disturbance than a rooftop installation (see Figure 3).

The remaining 50% of installed capacity is attributed to the behind the meter non-residential sector (47%) and the community solar sector (3%). Projects in the non-residential sector can be either ground mounted, canopy or rooftop installations at commercial entities, schools, or government properties (see Figures 4 and 5). Due to the variance between site types and size, projects in this sector can vary widely in capacity and necessary land area. More information on the community solar sector can be found in the next section, but largely, these projects can also vary in size (up to 5 MW) and must comply with strict siting provisions, steering development towards commercial rooftops, carports and canopies over parking lots, floating solar, and ground-mount arrays on landfills and other contaminated sites.

Figure 2. Example of residential rooftop solar PV.

Figure 3. Grid supply solar PV. The largest grid supply solar array in the State; 28.5 MW ground mounted array at Earle Naval Base in Tinton Falls, NJ. Image source: Nearmap

Figure 4. Non-residential behind the meter rooftop. Located at Central High School in Newark, NJ, this array totals 0.5 MW. Image source: Nearmap

Figure 5. Non-residential behind the meter elevated carport array(s). Located at CentraState Medical Center in Freehold, NJ these arrays total more than 5 MW. Image source: Nearmap

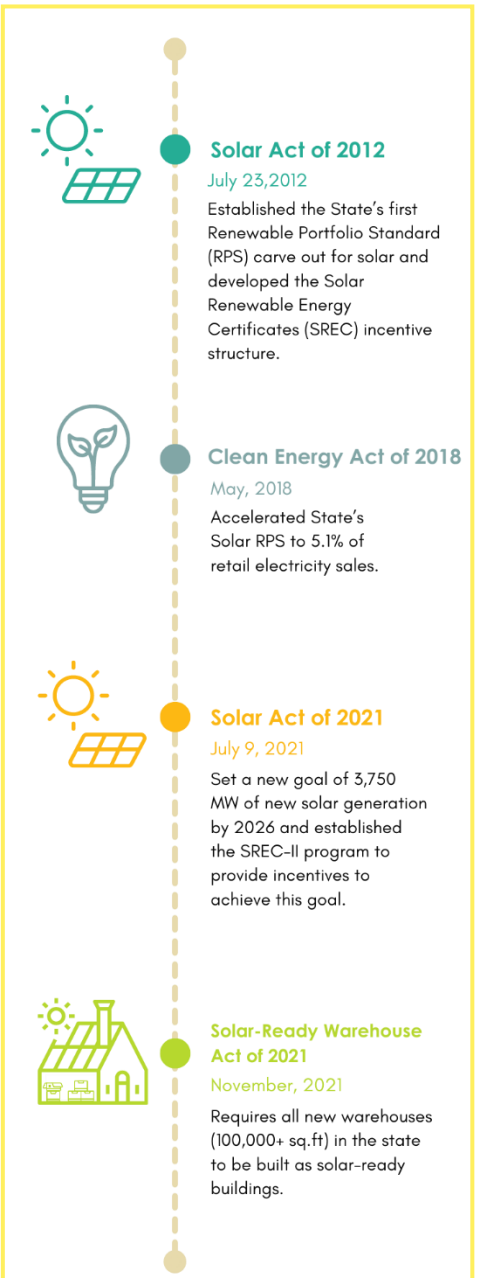


Figure 6. Timeline of Solar Legislation in New Jersey

Solar Regulations and Incentives

The Solar Act of 2012 is directly responsible for the growth of solar in New Jersey over the last decade. The Solar Act established the State's first Renewable Portfolio Standard (RPS) carve out for solar PV and developed an incentive structure with Solar Renewable Energy Certificates (SRECs) to subsidize the cost of this new clean energy technology. The Solar Act of 2012 also established "subsections" that set restrictions on siting grid supply solar projects by land type. Subsection r, along with other project criteria, restricted grid solar development from being sited on farmland (see Figure 7). Subsection s, by contrast, allowed for solar on certain agricultural lands. Subsection t set siting provisions to incentivize development on contaminated lands, such as properly closed landfills, brownfields, and areas of historic fill (see Figure 8).

In May 2018, Governor Murphy signed the Clean Energy Act of 2018, which updated and accelerated the solar requirement of the RPS to 5.1%, which the State attained in April 2020, triggering the closure of the SREC program. On July 9, 2021, Governor Murphy signed the Solar Act of 2021 (P.L. 2021, c. 169) into law which superseded the Solar Act of 2012 and set a new goal of 3,750 MW of new solar generation by 2026 and established a revamped SREC-II program to provide incentives to achieve this goal. To implement this increased target, the Board of Public Utilities issued a Board Order to establish a new Successor Solar Incentive (SuSI) Program (NJBPU, 2021). The SuSI program created two parallel incentive structures, the Administratively Determined Incentive (ADI) Program and the Competitive Solar Incentive (CSI) Program. The ADI program provides incentives for net metered residential and non-residential projects along with community solar projects 5 MW or less. The CSI program provides incentives for grid supply projects and net metered non-residential projects greater than 5 MW. These two programs are responsible for continuing the growth of solar in New Jersey by providing incentives to projects that meet the size and siting criteria established under each program.

In July 2021 legislation mandating a new Dual-Use Solar Energy Pilot Program (P.L. 2021, c. 170) was enacted. This law established a pilot program for the installation of solar panels on agricultural lands. The Dual-Use Pilot Program requires consultation from the Secretary of Agriculture and the Department and only considers qualifying farmlands that are unpreserved and remain in active agricultural or horticultural production, with additional siting prohibitions.

In November 2021, an additional law related to solar was enacted which requires all new planned warehouses (100,000 square feet or more) that are without completed permit approvals by July 1, 2022, to be solar ready, meaning at least 40 percent of the rooftop area shall be designated and reserved for future installations of solar photovoltaic or solar thermal systems (P.L. 2021, c. 290).

A permanent Community Solar Energy Program (CSEP) (NJBPU, 2023) was established on August 16, 2023, which replaced a very successful pilot program that was first opened in 2019. This program seeks to enable utility customers to participate in solar energy projects that are located remotely from their property. These projects can also vary in size and scope and must comply with specific siting provisions prior to approval. The CSEP opened with a capacity block of 225 MW which was quickly awarded to developers with eligible projects. On April 30, 2024, the capacity blocks were expanded to include an additional 275 MW of capacity, with the portal for submissions opening on May 15, 2024.

Figure 7. Subsection r project. 14.39 MW ground mounted grid supply array at Joint Base McGuire-Dix-Lakehurst (Manchester, NJ) approved under Subsection r of the Solar Act of 2012. Image source: Nearmap

Figure 8. Subsection t project. 12.99 MW ground mounted grid supply array at Cinnaminson Landfill (Cinnaminson, NJ) approved under Subsection t of the Solar Act of 2012. Image source: Nearmap

New Jersey's continued presence as a national leader in the solar sector, despite having a lower solar resource potential than many other states (~4.5 kWh/m^2/Day, see Figure 9), emphasizes the need to site solar in an environmentally responsible way. To achieve the Energy Master Plan's goal of 32 GW of solar by 2050, an additional 27 GW of solar will be needed over the next 26 years, at a rate of more than 1 GW of new solar annually[2]. In New Jersey, solar arrays on average have required 3 to 5 acres of land area per megawatt (MW) of installed solar capacity. Using this range as a baseline, in order to achieve the EMP goal, between 81,000 and 135,000 acres of land and rooftop space will be needed to site future solar panels and their associated infrastructure. As a result, it is critical that projects are properly sited to limit environmental disturbance wherever possible.

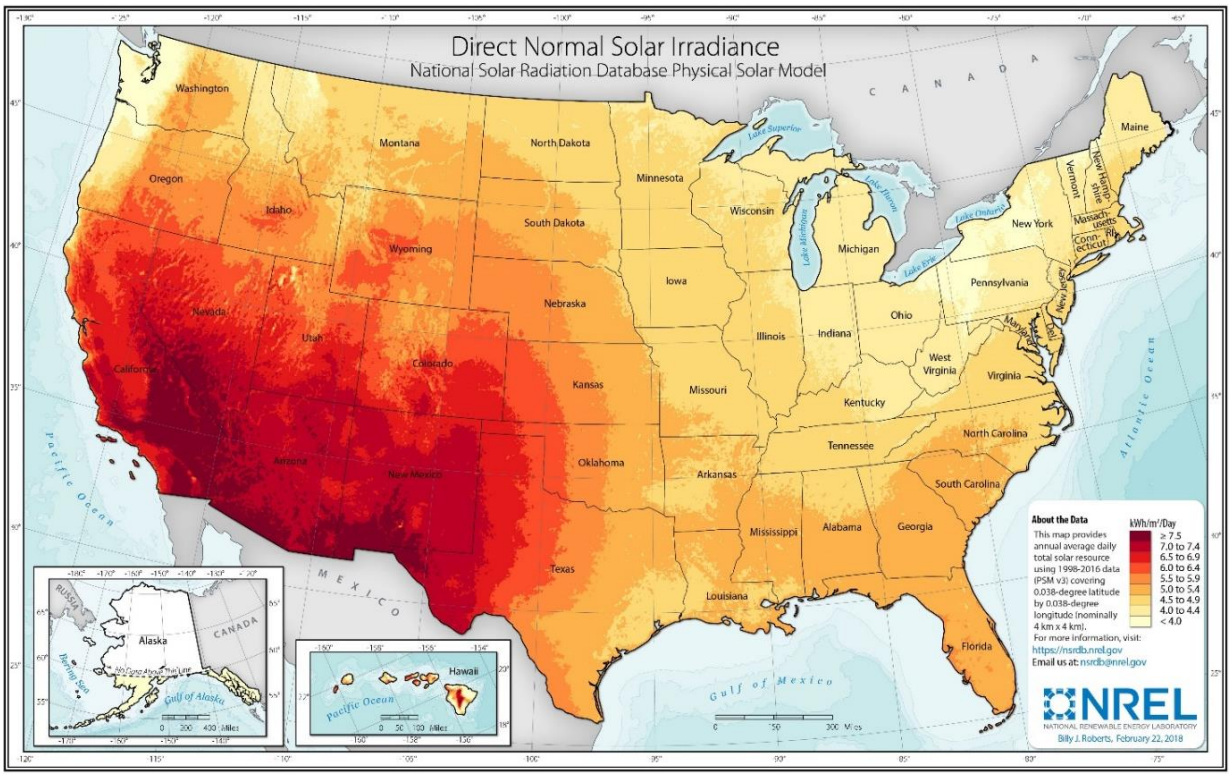


Figure 9: Direct Normal Solar Irradiance and Photovoltaic Solar Resource Potential of the United States (NREL, 2018)

[2] Assuming linear growth on an annual basis. Actual growth of installed solar will likely vary from year to year, based on the availability of incentives and solicitation awards under the SuSI Program.

ANALYTICAL METHODOLOGY

The Bureau of Climate Change and Clean Energy obtained input from State regulatory agencies and identified 20 GIS datasets to include in the generation of a composite solar siting score based on regulations, priorities, and the relevance of each layer towards development and siting of solar panels. Many of the data layers identified align with the Department's goals of protecting and preserving natural lands and critical habitats in the State. Each of the 20 layers leveraged in the analysis can be found in the section below under "Environmental Data Inputs."

To incorporate each of these datasets in a manner that considers them individually, as well as holistically, each layer was assigned a numerical score, or in some cases, tiered scores based on their attributes. Prior to assigning numerical values, each layer was first converted from polygon format to raster format with a 5 ft x 5 ft pixel resolution using the Feature to Raster Conversion Tool in ArcGIS Pro (Figure 10). Converting each layer to raster was essential in setting the foundation of the analysis, since raster datasets are better suited for completing quantitative analyses and map algebra functions, due to the normalization of the data into pixel cells of a uniform size containing numerical values.

Next, the desired values were assigned to each raster using the Reclassify tool in the Spatial Analyst Toolbox. Some rasters were given a single blanket score, while others were assigned tiered scores based on their attributes. The scores for each component raster were determined through meetings and discussions with program experts, management, and relevant staff, and were revised and refined numerous times through an iterative process of running the model with certain values and reviewing the results.

Once each raster was appropriately reclassified and scored, they were combined using the Weighted Sum function in the Spatial Analyst Toolbox. This function overlayed each of the 20 component rasters and utilized map algebra to take a sum of all of the overlapping values, both positive and negative, to generate a new raster that contains a composite score for each raster pixel.

Once generated, the resulting statewide raster was clipped to the New Jersey state boundary using the Extract by Mask function in the Spatial Analyst toolbox, and represents the new, refined NJDEP solar siting preference scores.

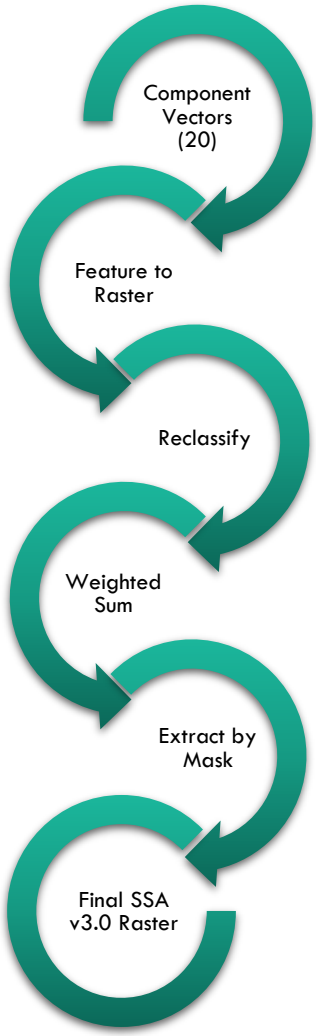


Figure 10: Solar Siting Analysis v3.0 Process Steps

The SSA v3.0 builds upon and enhances previous work from the Department related to the identification of the most preferred areas for siting solar PV. The previous publication, the Solar Siting Analysis Update (NJDEP, 2017) centered on assigning a solar siting preference to each Anderson Code classification in the New Jersey statewide Land Use / Land Cover (LU/LC) GIS dataset. Each Anderson Code was categorized as either "Preferred," "Not-Preferred," or "Indeterminate" for siting solar PV based on its unique characteristics. While the 2017 SSA Update has been widely used since its publication, its utility has been somewhat limited because it leveraged a single GIS dataset to determine the Department's solar siting preference. This new update, the SSA v3.0, considers and incorporates numerous other datasets to provide a more robust and up-to-date representation of the Department's solar siting preference statewide.

Environmental Data Inputs:

The 20 component data inputs used for the analysis, as well as their individual scores and justification for inclusion, can be found on the following pages (also see Table 2, or Appendix II). An asterisk (*) next to the score indicates that these layers were assigned values that would not be impacted by any of the other overlapping values in the model.

01 Buildings Greater than 200 square feet

Score: +50*

Rooftops are the most preferred locations for siting solar PV when considering environmental protection, as rooftop placement introduces little to no additional environmental disturbance. Further, New Jersey is an extremely densely populated and developed State, with more than 3 million buildings or structures greater than 200 square feet. These buildings represent a significant opportunity for solar PV development. To ensure that all building rooftops were scored equally and shown as a high preference, the building footprints layer[3] was assigned a value of +50 that could not be impacted by any of the other layers in the analysis. Despite their high score and preference for siting solar panels, all rooftops are not created equally and must be evaluated on a site-by-site basis for feasibility of siting panels and their associated infrastructure.

02 Impervious Surfaces

Score: +30*

Similar to building rooftops, impervious surfaces are also desirable locations for siting solar PV from an environmental protection perspective. Siting solar on existing impervious surfaces, such as elevated carports or canopies over large parking lots, minimizes environmental disturbance and can have other co-benefits. Like building rooftops, impervious surfaces (minus roadways), were assigned high positive values that could not be impacted by the scores of any other data layers.

03 Landfill Extents

Score: +30

Landfills are among the most preferred locations for siting solar PV. Installing solar panels and their associated infrastructure on top of properly closed landfills can be done in a manner that does not impact the integrity of the landfill cap and does not introduce additional environmental disturbance. Siting solar on landfills has been a priority of the State since the Solar Act of 2012, and these locations will continue to be leveraged to help achieve our solar goals. As a result, the layer depicting boundaries of known landfills in the State was assigned an individual score of +30.

04 Deed Notice Areas

Score: +20

Parcels assigned a deed notice indicate that they have on-site soil contamination in excess of the appropriate standard. As such, these contaminated parcels are often suitable candidates for siting solar PV, compared to other areas that do not possess soil contamination from a redevelopment standpoint. While every site possesses different characteristics, all sites that have been assigned a deed notice were scored +20 to improve their composite score compared to other "cleaner" sites.

05 Parcels with Contaminated Sites

Score: +20

All lands with contamination are not assigned deed notices. As a result, an additional data layer was derived by intersecting the NJDEP's Known Contaminated Sites List (KCSL) with the New Jersey Parcels & Mod IV dataset in order to identify a universe of parcels with known contaminated sites. Like designated parcels with deed notices, these contaminated lands would also be more preferred for redevelopment with solar PV, compared to other "clean" lands, so they too were assigned an individual score of +20.

[3] Building footprints layer was acquired from Nearmap based on a series of New Jersey statewide aerial imagery captures in March of 2023.

06 Brownfield Development Areas

Score: +10

A brownfield is any former or current commercial or industrial site that is currently vacant or underutilized and on which there has been, or is suspected to have been, a discharge of contamination. NJDEP has a long history of working with communities affected by multiple brownfields to design and implement remediation and reuse to occur in a coordinated fashion, within these defined Brownfield Development Areas. Since the Solar Act of 2012, siting solar PV on brownfields has been a preferred redevelopment method for these sites, due to the benefits of developing clean energy on an otherwise underutilized site. As a result, these broad boundaries were incorporated into the analysis with a value of +10.

07 Land Use/Land Cover

Score: Varied -10 to +10

The 2020 Land Use/Land Cover dataset classifies the entire State of New Jersey into various land use/land cover categories and Anderson Codes. These codes describe the natural characteristics of the land, as well as various types of development. For this analysis, each individual Anderson Code was assigned a preference and suitability score that went into the overall analysis. Individual scores ranged from -10 to +10. A full list of scores for each Anderson Code can be found in Appendix II.

08 Pinelands Preservation Area

Score: -5

The Pinelands National Reserve makes up over 22% of New Jersey's land area, with over 1.1 million acres of land. The reserve is home to dozens of rare plant and animal species, as well as other critical natural resources. The Pinelands Preservation Area is at the heart of this, spanning nearly 300,000 acres in the most critical ecological region. While development within this area is discouraged, there may be opportunities for solar PV on existing impervious surfaces or areas of contamination. As a result, the Pinelands Preservation Area was assigned a value of -5.

09 Highlands Preservation Area

Score: -5

The Highlands region consists of nearly 860,000 acres of forested ridges, rolling farmlands, abundant wildlife, significant historic and scenic resources, and diverse recreational opportunities. In addition, the Highlands provide nearly 6.2 million New Jerseyan's with clean drinking water. The Highlands Preservation Area consists of 398,000 acres of land, approximately 145,000 acres of which are undeveloped. While development within this area is discouraged, there may be opportunities for solar PV on existing impervious surfaces or areas of contamination. As a result, the Highlands Preservation Area was assigned a value of -5.

10 Natural Heritage Priority Sites

Score: -10

The Office of Natural Lands Management has identified 343 Natural Heritage Priority Sites in the State, representing some of the best remaining habitat for rare species and rare ecological communities. These areas should be considered a top priority for preservation of biological diversity in New Jersey. If these sites become degraded, destroyed, or developed, New Jersey could lose some of the unique components of its natural heritage. For the analysis, Natural Heritage Priority Sites were scored at -10.

11 Terrestrial Wildlife Habitat Cores and Corridors (CHANJ)

Score: -10

The Connecting Habitats Across New Jersey (CHANJ) project represents a strategic plan for wildlife conservation that delineates and provides a common vision for a connected statewide landscape that, if protected and appropriately managed, will restore and maintain gene flow between viable breeding population of terrestrial, native wildlife species, helping to ensure their long-term viability in New Jersey. These mapped cores and corridors are an attempt to identify and maintain habitat connectivity through conservation and preservation and were integrated into the analysis as -10.

12 Riparian Corridors

Score: -10

Riparian corridors consist of vegetation growing near rivers, streams, lakes, lagoons, or other natural bodies of water, typically approximately 300 feet along both sides of the water body. Riparian corridors serve many different ecological functions, thus preserving such areas is essential to protecting New Jersey's natural resources and water supply. Construction, including for renewable energy siting, is not preferred in these locations, so they were scored as -10.

13 Marsh Retreat (3 Ft. Sea Level Rise)

Score: -10

This modeling was completed by the Rutgers University Center for Remote Sensing and Spatial Analysis and shows the current extent of tidal marshes in New Jersey, as well as the likelihood of conversion under a 3-foot sea level rise scenario. Similar to existing flood hazard areas, development of ground mount arrays in these areas should be discouraged to account for projected future changes. These areas of marsh retreat were scored as -10.

14 Landscape Project 3.3 Habitat Rank

Score: Varied -15, -10. -5

The Landscape Project 3.3 displays wildlife habitat throughout the state ranked according to rarity of the species which occur in specific patches of habitat. Habitat ranks 3, 4, and 5 indicate the critical habitats for species that may be threatened or endangered on the State and Federal levels. Development in these areas, even for renewable energy, is not preferred in order to maintain the integrity of these critical habitats. For the analysis, the scoring breakdown is as follows:

- Rank 3 Habitats (State Threatened) (-5)
- Rank 4 Habitats (State Endangered) (-10)
- Rank 5 Habitats (Federally Listed) (-15)

15 FEMA Flood Hazard Areas

Score: Varied -15, -10. -5

FEMA Flood Hazard Areas are defined as the area that will be inundated by the flood event having a 1-percent chance of being equaled or exceeded in any given year (also known as the 100-year floodplain). These designations are important as the basis of floodplain management regulations for communities across the country and dictate whether or not flood insurance is required. For this analysis, different zone designations were assigned tiered scores in an effort to dissuade development of ground mount solar arrays in these flood prone areas. The scoring breakdown is as follows:

- Floodways (-15)
- AE, AO, and VE Zones (-10)
- A & AH Zones (-5)

16 State, Local, and Nonprofit Open Space

Score: -20

These lands are preserved as open space for recreation and/or conservation purposes, including but not limited to parkland, natural areas, greenways, ecologically sensitive areas, and lands providing passive and active recreational opportunities. As such, these lands should not be sought after for solar PV development, although opportunities may arise on existing impervious surfaces, such as rooftops, pavilions, parking lots, etc. Designated open space was assigned a value of -20 in the analysis.

17 Wildlife Management Areas

Score: -20

Wildlife Management Areas are lands that have been set aside for protection and conservation purposes. These areas seek to provide recreational opportunities as well as wildlife habitat conservation. As a result, these areas should not be considered for any development, including solar PV, and were scored as -20 in the analysis.

18 Agricultural Land Uses in Agricultural Development Areas

Score: -25

Agricultural Development Areas consist of parcels where a county's agricultural development board has determined that agriculture is the preferred, but not necessarily that exclusive, use of land over the long term. Protection of these agricultural lands from development helps to ensure that their agricultural benefits and contiguity are maintained. For this layer, agricultural land uses (from the 2020 Land Use/Land Cover layer) located within the boundaries of an Agricultural Development Area, were assigned a value of -25 to indicate their low preference for siting solar PV so that they may be maintained for agricultural purposes.

19 Roadways

Score: -30

Despite their impervious qualities, roadways are not preferred for siting solar PV from a suitability standpoint. Elevated canopies over roadways have not been proven as commercially viable or practical. For the analysis, roadways were assigned a score of -30 to ensure that all roadways are shown as low preference.

20 Preserved Farmland

Score: -100*

Farms or development easements that are acquired through the New Jersey Farmland Preservation Program will forever be protected for agricultural use. Understanding the value of these properties and maintaining their agricultural integrity, solar PV development is prohibited on these lands. Preserved farmland parcels have been assigned a score of -100 that cannot be impacted by any other data layers to ensure their low preference score.

Table 2: SSA v3.0 Component Layers and Scoring. An asterisk (*) indicates that these layers were assigned values that would not be impacted by any of the other overlapping values in the model. All values can be found in Appendix II.

SSA v3.0 Component Layers	Score
Buildings Greater than 200 sq ft	+50*
Impervious Surfaces	+30*
Landfill Extents	+30
Deed Notice Areas	+20
Parcels with Contaminated Sites	+20
Brownfield Development Areas	+10
Land Use/Land Cover	varied +10 to -10
Pinelands Preservation Area	-5
Highlands Preservation Area	-5
Natural Heritage Priority Sites	-10

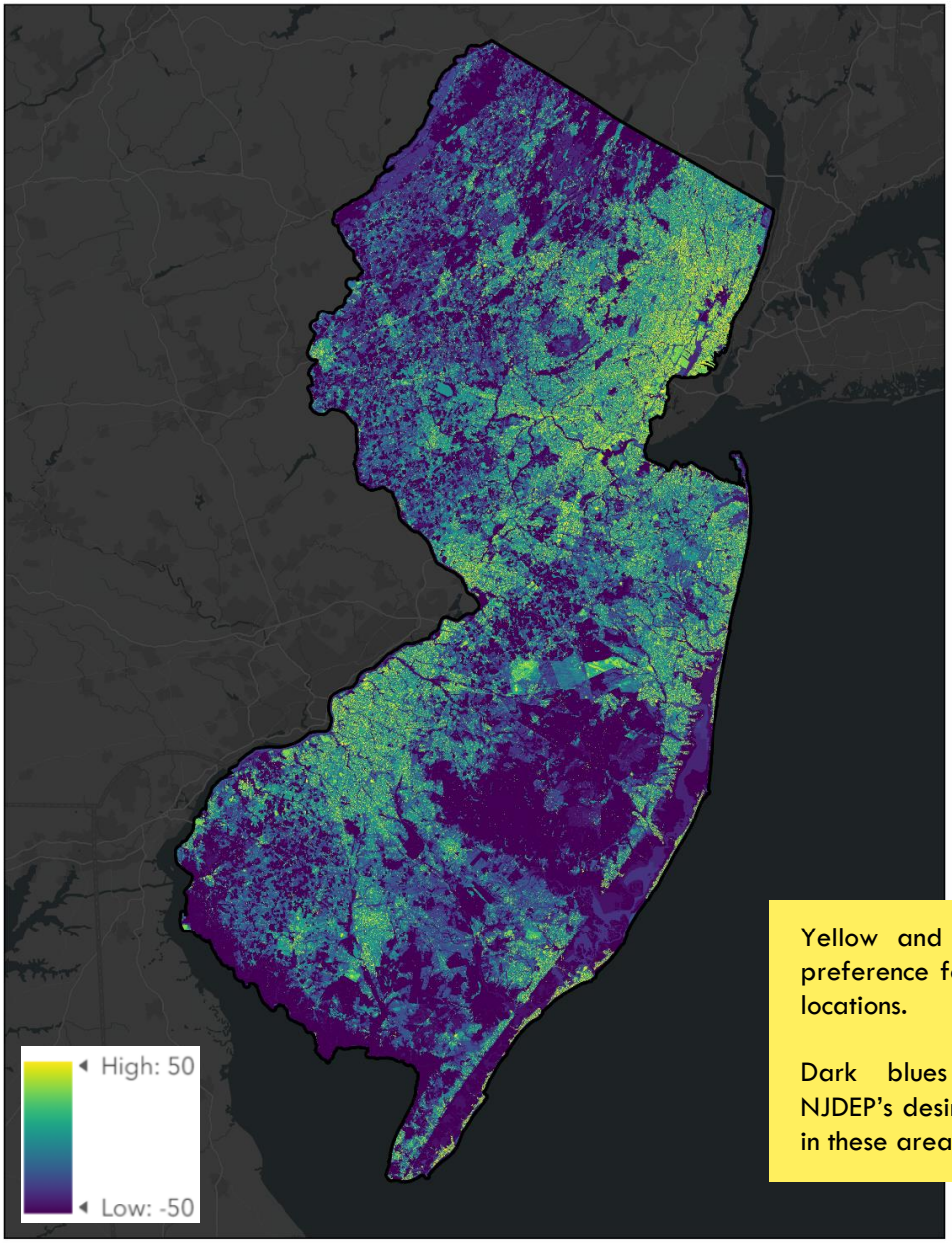
SSA v3.0 Component Layers	Score
Terrestrial Wildlife Habitat Cores and Corridors (CHANJ)	-10
Riparian Corridors	-10
Marsh Retreat (3 ft Sea Level Rise)	-10
Landscape Project 3.3 Habitat Rank	varied -15, -10, -5
FEMA Flood Hazard Areas	varied -15, -10, -5
State, Local and Nonprofit Open Space	-20
Wildlife Management Areas	-20
Agricultural Land Uses in Agricultural Development Areas	-25
Roadways	-30
Preserved Farmland	-100*

Links to each of the component GIS data layers can be found in the section titled “Other Resources”.

ANALYTICAL RESULTS & DISCUSSION

The Solar Siting Analysis Version 3.0 presents a significant improvement over the previous iterations in that it provides greater refinement in identifying the Department's most and least preferred areas for siting solar. Whereas the previous iterations solely relied on assigning a siting preference to the Land Use/Land Cover dataset, this new version leverages 19 additional datasets and a more involved quantitative analysis to determine the siting preference. Doing so enables this analysis to provide a more refined delineation of environmentally sensitive areas and identify more preferred lands for solar development.

The new solar siting composite score raster dataset that resulted from the analysis outlined in the section above has been published and made available publicly in ArcGIS Online. This new raster has been symbolized by siting score and can be seen in the image below (Figure 11).



In the image, brighter colors (yellows and greens) symbolize higher siting scores, while the darker colors (blues and purples) indicate lower siting scores. At the statewide scale, the higher siting scores follow development corridors and urban centers, while the lower scores generally represent more rural and natural lands in the State.

Yellow and greens indicate NJDEP's preference for siting solar PV in these locations.

Dark blues and purples indicate NJDEP's desire to avoid siting solar PV in these areas, whenever possible.

Figure 11. Solar Siting Analysis Version 3.0 Statewide Raster

However, more nuances can be seen when the State is viewed at a zoomed in scale since the raster dataset for the analysis was completed at a very high resolution (5x5 feet). As seen in Figure 12 below, when zoomed in, parcel level details are visible in the raster color gradient more clearly, shown here for sections of South Plainfield and Edison.

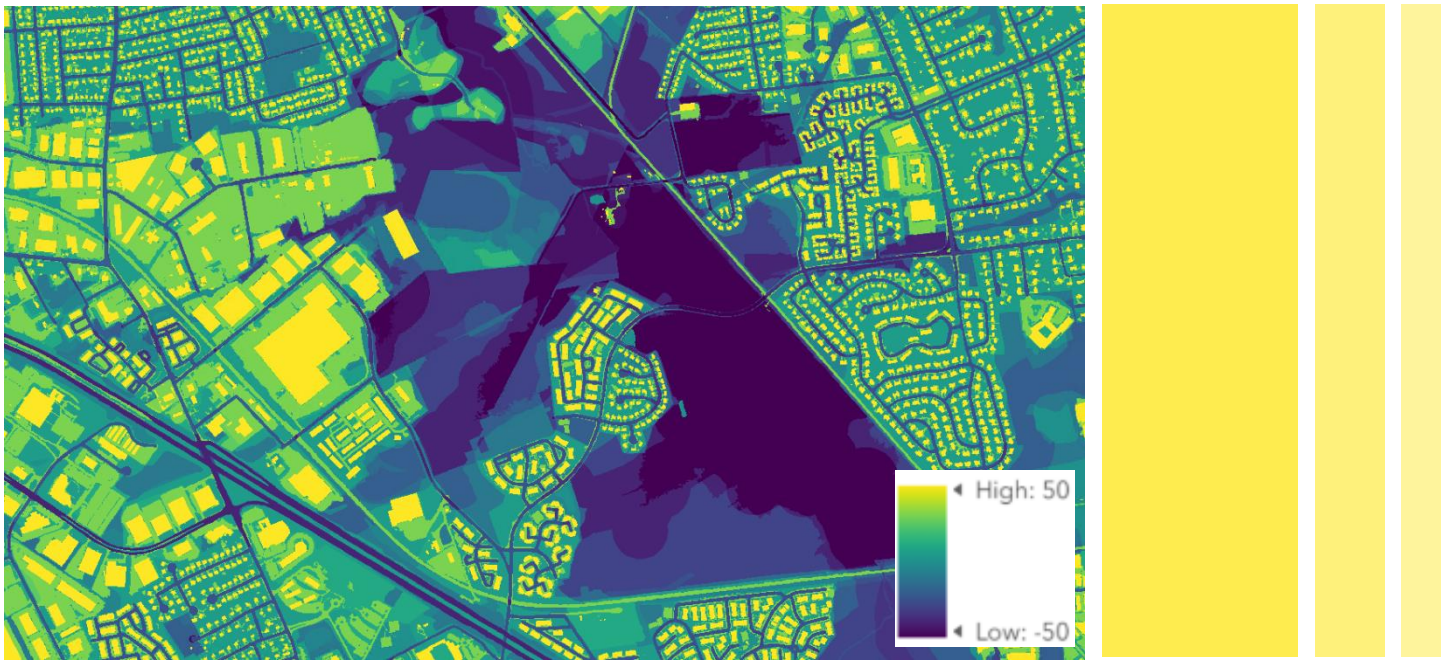


Figure 12. Solar Siting Analysis Version 3.0, Sections of South Plainfield and Edison.

In the image above, greater detail can be seen. First and foremost, many individual residential and commercial rooftops are shown in the brightest yellow color, indicating their high solar siting preference. There are also other impervious surfaces, like large commercial parking lots, that are illustrated in bright green colors. As you look further to the east, more of the dark colors come through, indicating a low siting preference, as natural lands like forests and wetlands are present, which can be confirmed in the reference imagery snapshot below (see Figure 13).

Figure 13. Aerial Imagery of Sections of South Plainfield and Edison (Image Source: Nearmap

Table 3 below displays the acreage breakdown for each siting score generated through the analysis. For grouping purposes, 7 "Siting Tiers" were established, based on ranges of scores and broad similarities between sites that may share relative scores.

Tier 1 and Tier 2 sites are generally the most preferred locations for siting solar PV based on their urban/developed characteristics, as well as the potential for site contamination that may benefit from redevelopment in the form of clean energy. Siting solar PV in these areas may incur some environmental disturbance, but the impact may be limited based on the land characteristics or rooftops that a potential project may inhabit. These Tiers account for just over 10% of the State, totaling more than 500,000 acres of land area.

Tiers 3, 4 and 5 account for nearly 2 million acres of land area (38.5%) and can be seen generally as moderately preferred locations for siting solar PV. These types of sites can vary greatly and can range from miscellaneous urban lands to some lower priority natural lands and agricultural lands. As is the case with all solar projects, any considerations for siting solar projects on lands that fall into these Tiers should be evaluated on a site-by-site basis, as some may be better candidates than others from an environmentally sensitive siting standpoint.

Tiers 6 and 7 represent the least preferred lands for siting solar PV identified through this analysis. These Tiers account for just over 50% of the State (nearly 2.6 million acres of land) and are widely characterized as natural lands such as forests and wetlands, and in some cases protected lands that prohibit solar and other development, such as preserved farmland.

Table 3: Acreage by Solar Siting Tier and NJDEP preferability.

	Siting Tier	Score	Acreage	Percentage
Most Preferred	Tier 1	50+	174,781.45	3.5%
	Tier 2	45	1,379.47	6.7%
		40	3,198.81	
		35	2,651.46	
		30	323,736.44	
Moderately Preferred	Tier 3	25	9,360.64	0.5%
		20	8,633.74	
		15	7,521.82	
	Tier 4	10	51,267.49	23.2%
		5	553,817.86	
		0	189,724.54	
		-5	190,248.64	
		-10	168,518.93	
	Tier 5	-15	103,743.08	14.8%
		-20	270,621.18	
		-25	362,113.53	
Least Preferred	Tier 6	-30	329,064.18	23.3%
		-35	320,964.57	
		-40	271,556.82	
		-45	234,806.68	
	Tier 7	-50+	1,392,017.12	28.0%
	TOTAL		4,969,728.44	100.0%

The scores and Tiers derived from this analysis are only intended to be used as guidance for siting solar PV. The composite solar siting score raster and any web mapping applications that are developed can be used to screen and identify sites but are not an indication as to whether a proposed solar project will be approved or denied.

Achieving the 2019 Energy Master Plan goal of approximately 27 GW of new solar PV over the next 26 years, requires siting solar panels and their associated infrastructure on roughly 81,000 to 135,000 acres of land. While the SSA v3.0 is not intended to be utilized as an indicator of whether proposed solar projects would be approved or denied, it does identify areas of higher preference for siting solar panels from an environmental standpoint. The results have identified more than 500,000 acres of land area that fall into the top 2 siting Tiers, indicating the highest preference for siting projects in these areas, and an additional 1.1 million acres of land area in Tiers 3 and 4. Building out all of the solar projects called for in the EMP would consume less than 8% of the total acreage in Tiers 1 through 4.

Case Study: Cheesequake State Park

The series of images below (Figure 14) provide a glimpse of how each of the component data layers, with their individual scores, combine to generate the final solar siting composite score raster dataset through the analysis, in this case for a section of the State near Cheesequake State Park in Matawan, NJ.

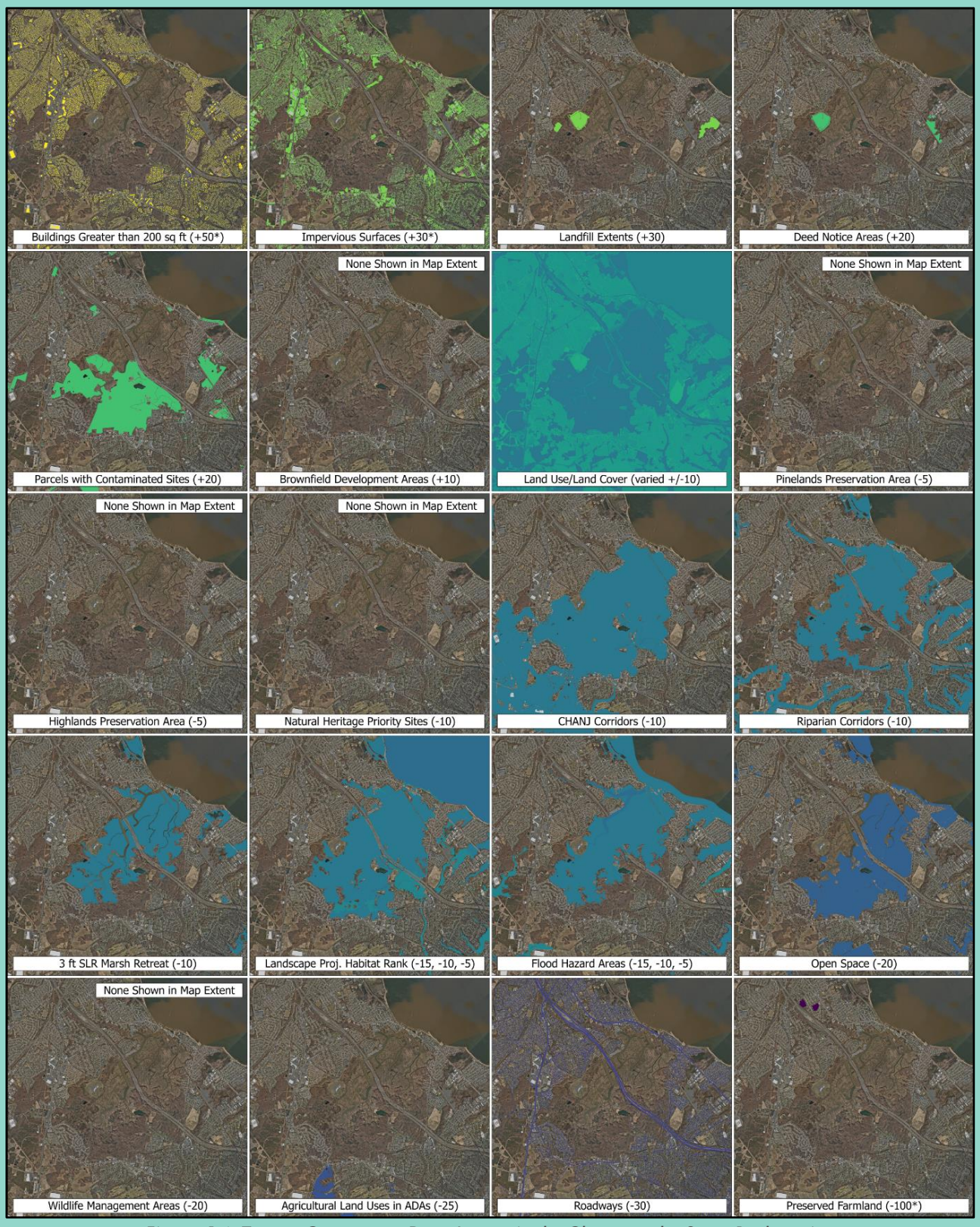


Figure 14. Twenty Component Data Layers in the Cheesequake State Park region

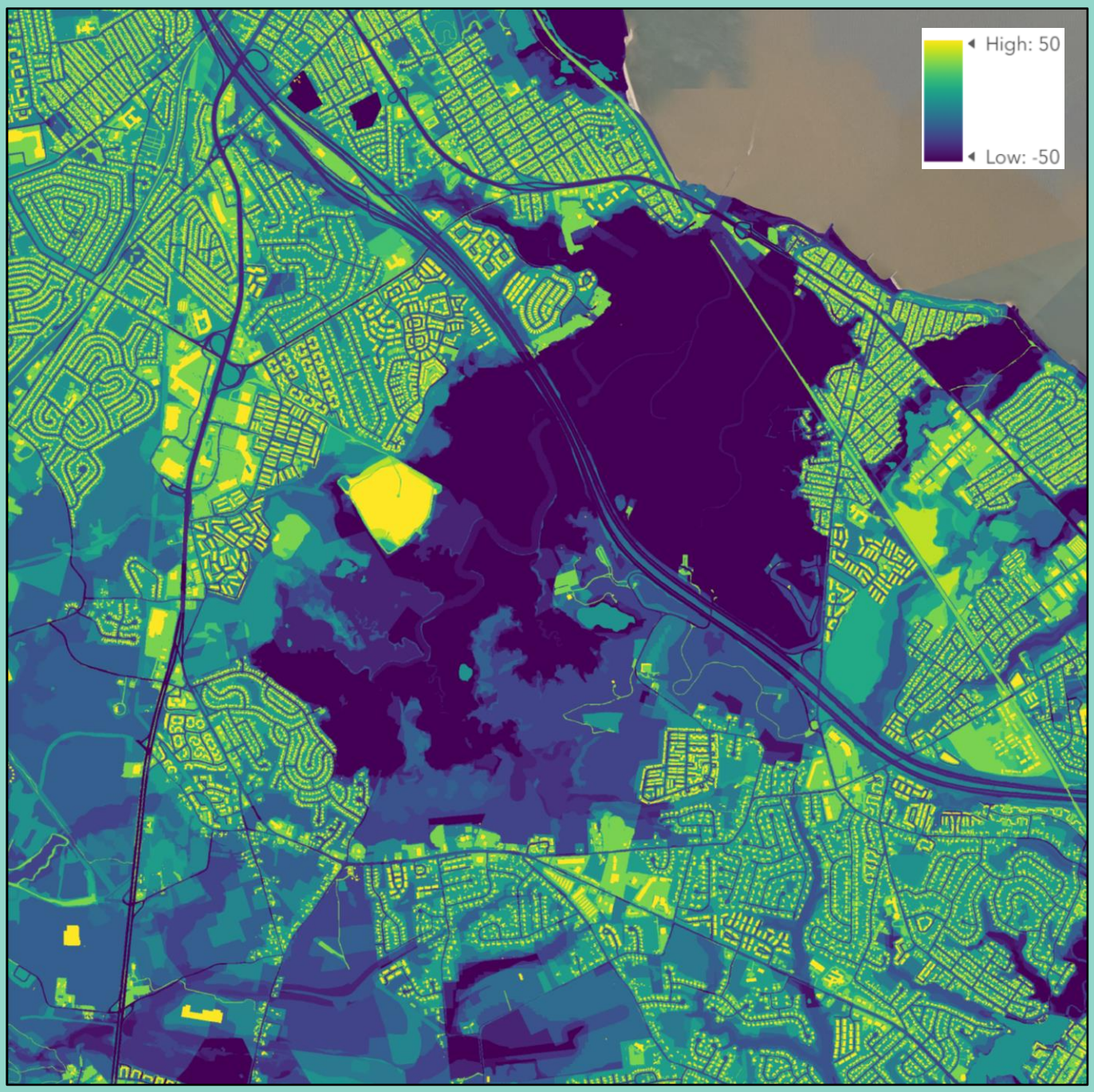


Figure 15. Solar Siting Composite Score of Cheesequake State Park Region.

Each of the 20 component data layers are shown in the map series in Figure 14 and were uniquely scored and symbolized (where shades of blue and purple indicate "subtractors", while shades of green and yellow indicate "adders"). As each of these layers were stacked on top of each other through the "weighted sum" tool, the values were combined, in either the positive or negative direction. As can be seen in the map series (Figure 14) and the composite score image (Figure 15), Cheesequake State Park contains multiple subtractors, including designated open space, flood hazard areas, riparian corridors, and critical habitats, leading this area to score very low from a solar siting preference standpoint, hence the darker shades of blue and purple in the composite score image. However, some of the surrounding lands contain numerous building footprints and impervious surfaces, as well as landfills and parcels with contaminated sites, which result in higher siting preference scores, as indicated by the yellow and green colors.

USING THE SOLAR SITING ANALYSIS V3.0 COMPOSITE SCORE RASTER

The solar siting composite score raster derived through the analysis is available for download and is also available in ArcGIS Online for users to leverage as guidance for identifying preferred locations for siting solar projects. Experienced users with ArcGIS Pro can download the SSA v3.0 raster dataset and conduct more in-depth analyses of certain locations, if desired, such as the example below which show the breakdown of siting scores in Overburdened Communities under the New Jersey Environmental Justice Law (2022).

Overburdened Communities

Overburdened Communities (OBCs) in New Jersey, designated under the Environmental Justice Law (2022) account for 21% of the total statewide acreage (1,059,470.96 acres). A screening of these communities compared against the SSA v3.0 composite solar siting scoring raster indicates that 20.7% of OBC's land area fall into Tiers 1 & 2 (219,294.47 acres). An additional 52.5% of land area falls in Tiers 3, 4 & 5 (556,718.42 acres), while the remaining 26.8% of land area is classified as Tiers 6 & 7 (283,458.08 acres).

Figure 15 displays the SSA v3.0 composite score GIS layer within the State's OBC boundaries, while Table 4 provides an in-depth breakdown of the acreage of each of the Siting Tiers within these communities.

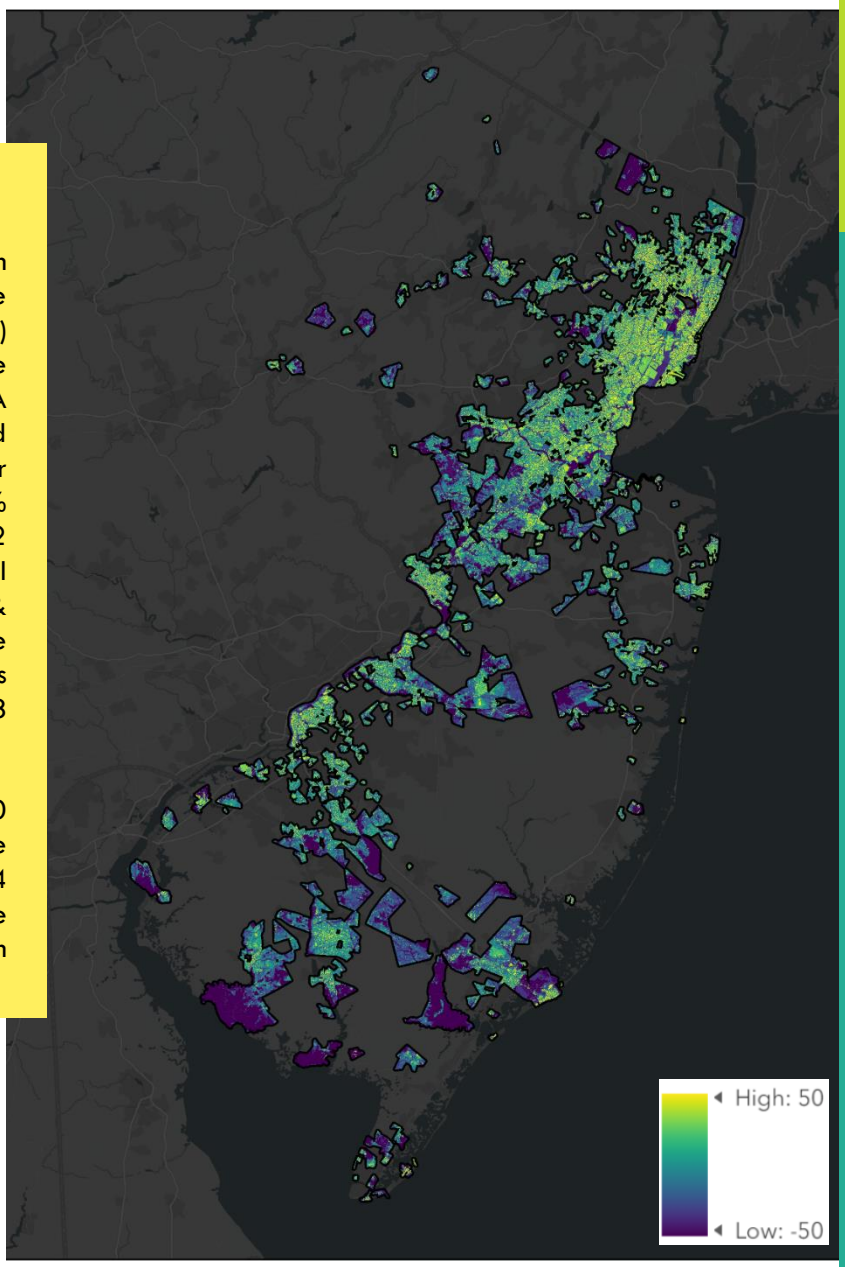


Figure 16. Composite Score New Jersey's Overburdened Communities.

Table 4: Acreage breakdown for each siting score in New Jersey's Overburdened Communities.

	Siting Tier	Score	Acreage	Percentage
Most Preferred	Tier 1	50+	76,911.19	7.3%
	Tier 2	45	1,358.25	13.4%
		40	1,100.80	
		35	135,675.00	
		30	4,249.22	
Moderately Preferred	Tier 3	25	4,482.68	2.7%
		20	3,889.30	
		15	19,723.72	
	Tier 4	10	158,990.17	30.0%
		5	42,239.38	
		0	46,845.25	
		-5	43,863.19	
		-10	25,400.08	
	Tier 5	-15	62,268.01	19.9%
		-20	90,835.71	
		-25	58,180.92	
Least Preferred	Tier 6	-30	42,087.67	13.6%
		-35	45,492.39	
		-40	29,383.39	
		-45	26,632.62	
	Tier 7	-50+	139,862.00	13.2%
	Total		**1,059,470.96**	**100.0%**

Other analyses can be conducted, such as breakdowns of siting scores and preference within municipal boundaries, as shown in Figure 17 below for Bellmawr Borough, as well as comparisons between municipalities with regards to available preferred locations.

Figure 17. Solar Siting Analysis v3.0 within Bellmawr Borough, New Jersey

Less technical users can also leverage the web mapping application that has been developed and published in ArcGIS Online to search for specific locations and view the solar siting scores generated through this analysis. Each of the 20 component layers of the analysis are also included in this web mapping application, so users can get a better understanding of why sites may be scored the way they are, based on the sum of the component layers that can be found at that site.

CONCLUSION

The Solar Siting Analysis Version 3.0 represents a snapshot of the Department's statewide solar siting preference. Over time, this is likely to change as updates to each of the 20 component data layers are published, and new data layers are identified that can be leveraged in future iterations of the analysis. For example, some datasets, including the threatened and endangered species habitat dataset, are pending significant revisions that may shift existing habitat boundaries or introduce new areas that may be low siting preference for solar due to the existence of critical habitats. The Department will continue to track the status of each of the component datasets and may publish updates to the Solar Siting Analysis as needed.

It will also be important to continue to track developments in the solar industry and incorporate these technological breakthroughs and account for them in the analysis as needed. For example, floating solar is a relatively new type of solar application that, as the name alludes, incorporates solar PV panels on top of floating docks or ballasts on bodies of water. As this technology continues to mature, it may be beneficial to identify water bodies that may be better suited for floating solar (such as sand and gravel pits/blue holes, or other water bodies that do not possess very much ecological or recreational value) and incorporate them into the analysis as preferred sites. In the current iteration of the analysis, most non-tidal water bodies are classified as Tier 4 sites (moderately preferred).

Solar energy will continue to be an integral component of New Jersey's clean energy picture as we move into the future. Despite the benefits of this clean energy technology, projects should be sited in an environmentally responsible manner to ensure the State is able to achieve our clean energy goals without jeopardizing the natural environment and any ecosystem services or recreational services that it provides.

ACRONYMS

ADI	Administratively Determined Incentive
CSEP	Community Solar Energy Program
CSI	Competitive Solar Incentive
EMP	New Jersey Energy Master Plan
GIS	Geographic Information Systems
GW	Gigawatts
KCSL	Known Contaminated Site List
kW	Kilowatts
LC	Land Cover
LU	Land Use
MW	Megawatts
OBC	Overburdened Communities
PV	Photovoltaic
RPS	Renewable Portfolio Standard
SREC	Solar Renewable Energy Certificate
SuSI	Successor Solar Incentive

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OTHER RESOURCES

Component GIS Data Layer Links:

1. Building Footprints*
   *The building footprints layer used for the analysis was purchased from Nearmap. The raw data for this cannot be published externally. The link above directs to a dataset of building footprints that has been published, based on LiDAR, the 2015 Land Use/Land Cover, and other inputs.
2. Impervious Surfaces
3. Landfill Extents
4. Deed Notice Areas
5. Known Contaminated Sites List (intersected with Parcels & Mod IV)
6. Brownfield Development Areas
7. Land Use/Land Cover (2020)
8. Pinelands Preservation Area
9. Highlands Preservation Area
10. Natural Heritage Priority Sites
11. Connecting Habitats Across NJ
12. Riparian Corridors ("Riparian" attribute in Landscape Project 3.3 – 5 data regions)
    a. Atlantic Coastal Region
    b. Delaware Bay Region
    c. Piedmont Plains Region
    d. Pinelands Region
    e. Skylands Region
13. Marsh Retreat (3 foot SLR)
14. Landscape Project 3.3 (5 data regions)
    a. Atlantic Coastal Region
    b. Delaware Bay Region
    c. Piedmont Plains Region
    d. Pinelands Region
    e. Skylands Region
15. FEMA Flood Hazard Areas
16. State, Local and Nonprofit Open Space
17. Wildlife Management Areas ("Primary Use" attribute in Open Space dataset)
18. Agricultural Development Areas (intersect Agriculture "LU TYPE" from LU/LC within ADA boundaries)
19. Roadways
20. Preserved Farmland

APPENDICES

Appendix I:

State installed solar PV capacity (MW), rankings based on installed capacity, the total land area (sq mi), capacity per sq mi, as well as the ranking based on installed capacity per sq mi of land area. Installed solar PV capacity was obtained from the Solar Energy Industries Association (SEIA) state-by-state map[4], while Statewide land area was obtained via U.S. Census/Wikipedia[5].

State	Capacity (MW)	Capacity Ranking	Land Area (sq mi)	Capacity per sq mi	Capacity per sq mi Ranking
California	46,874	1	155,779.22	0.301	5
Texas	22,872	2	261,231.71	0.088	14
Florida	13,912	3	53,624.76	0.259	7
North Carolina	9,310	4	48,617.91	0.191	9
Arizona	7,675	5	113,594.08	0.068	16
Nevada	6,382	6	109,781.18	0.058	17
Georgia	5,913	7	57,513.49	0.103	13
New York	5,560	8	47,126.40	0.118	12
Massachusetts	5,070	9	7,800.06	0.650	3
New Jersey	4,847	10	7,354.22	0.659	2
Virginia	4,841	11	39,490.09	0.123	11
Colorado	4,112	12	103,641.89	0.040	23
Minnesota	2,796	13	79,626.74	0.035	24
Utah	2,753	14	82,169.62	0.034	25
Illinois	2,719	15	55,518.93	0.049	20
South Carolina	2,554	16	30,060.70	0.085	15
Ohio	2,275	17	40,860.69	0.056	18
Wisconsin	2,204	18	54,157.80	0.041	22
Maryland	2,054	19	9,707.24	0.212	8
Indiana	1,895	20	35,826.11	0.053	19
New Mexico	1,890	21	121,298.15	0.016	34
Hawaii	1,808	22	6,422.63	0.282	6
Oregon	1,776	23	95,988.01	0.019	31
Pennsylvania	1,491	24	44,742.70	0.033	26
Connecticut	1,481	25	4,842.36	0.306	4
Michigan	1,444	26	56,538.90	0.026	29
Maine	993	27	30,842.92	0.032	27
Rhode Island	967	28	1,033.81	0.935	1
Arkansas	895	29	52,035.48	0.017	32
Tennessee	889	30	41,234.90	0.022	30
Idaho	830	31	82,643.12	0.010	38
Alabama	823	32	50,645.33	0.016	33
Washington	682	33	66,455.52	0.010	37
Missouri	627	34	68,741.52	0.009	39
Iowa	601	35	55,857.13	0.011	36
Mississippi	576	36	46,923.27	0.012	35
Vermont	429	37	9,216.66	0.047	21
Louisiana	352	38	43,203.90	0.008	40
Montana	293	39	145,545.80	0.002	43
Delaware	279	40	1,948.54	0.143	10
New Hampshire	263	41	8,952.65	0.029	28
Kentucky	192	42	39,486.34	0.005	41
Oklahoma	181	43	68,594.92	0.003	42
Kansas	152	44	81,758.72	0.002	44
Wyoming	124	45	97,093.14	0.001	47
South Dakota	102	46	75,811.00	0.001	46
Nebraska	96	47	76,824.17	0.001	48
West Virginia	38	48	24,038.21	0.002	45
Alaska	30	49	570,640.95	0.000	49
North Dakota	2	50	69,000.80	0.000	50

[4] Solar State by State (SEIA): https://www.seia.org/states-map
[5] List of US States by Area: https://en.wikipedia.org/wiki/List_of_U.S._states_and_territories_by_area

Appendix II:

Full table of component data layers with individual scores used in the analysis. An asterisk (*) indicates that these layers were assigned values that would not be impacted by any of the other overlapping values in the model.

Component Data Layer	Individual Siting Score (pre-model)
Buildings Greater than 200 square feet	+50*
Impervious Surfaces	+30*
Landfill Extents	+30
Deed Notice Areas	+20
Parcels with Contaminated Sites	+20
Brownfield Development Areas	+10
Land Use/Land Cover	
Anderson Codes: 1200, 1300, 1500, 7300, 7400, 7500, 7600	+10
Anderson Codes: 1110, 1120, 1130, 1140, 1150, 1411, 1462, 1463, 1499, 1600, 1700, 1810, 2100, 2200, 2300, 2400	+5
Anderson Codes: 1211, 1214, 1400, 1710, 1741, 1800, 1804, 4230, 4410, 4411, 4500, 5200, 5300, 7200	0
Anderson Codes: 2140, 2150, 4420, 4430, 4440, 5100, 5190, 5410, 5411, 5412, 5420, 6500, 7430	-5
Anderson Codes: 1410, 1419, 1420, 1440, 1461, 1711, 1750, 1850, 4110, 4120, 4210, 4220, 4311, 4312, 4321, 4322, 5430, 6111, 6112, 6120, 6130, 6141, 6210, 6220, 6221, 6231, 6232, 6233, 6234, 6240, 6241, 6251, 6252, 6290, 7100, 7440	-10
Pinelands Preservation Area	-5
Highlands Preservation Area	-5
Natural Heritage Priority Sites	-10
Terrestrial Wildlife Habitat Cores and Corridors (CHANJ)	-10
Riparian Corridors	-10
Marsh Retreat (3 ft Sea Level Rise)	-10
Landscape Project 3.3 Habitat Rank	
Rank 5 (Federally Listed)	-15
Rank 4 (State Endangered)	-10
Rank 3 (State Threatened)	-5
FEMA Flood Hazard Areas	
Floodways	-15
AE, AO, and VE Zones	-10
A & AH Zones	-5
State, Local and Nonprofit Open Space	-20
Wildlife Management Areas	-20
Agricultural Land Uses in Agricultural Development Areas	-25
Roadways	-30
Preserved Farmland	-100*