<u>ASRC Report:</u>

Photovoltaic Covered Parking Lots

A Survey of Deployable Space In the Hudson River Valley, New York City, and Long Island, New York

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OBJECTIVE

Along with building rooftops, facades and exclusion zones, parking lots represent an opportunity for the deployment of Photovoltaics (PV) on already built or otherwise occupied spaces. This is particularly important in areas where free open space is limited and where PV generation within or near load centers has demonstrated grid support benefits such as peak demand mitigation (2, 4.)

At a time when technologies for parking lot deployment are being readied, the purpose of this study is to determine the space available in parking lots in New York State's most capacity constrained regions; The Hudson Valley, New York City Metro area, and Long Island.*

METHODS

We gathered information about the location, size and obstructions for each parking lot in the selected region by observing high-resolution satellite/aerial images of nineteen counties from Saratoga Springs to the tip of Long Island. These photographs were viewed using the New York State Interactive Mapping Gateway created by the New York State Geographic Information Systems Clearing House (8.) This program includes features that allowed us to determine the size of each parking lot as well as its exact location within a half mile. (Fig. 1a) This function in turn allowed us to record not only the coordinates of each parking lot, but also the county the lot was observed in. To verify the accuracy of the program, we compared the specifications of several parking lots topographic maps known to be accurate.

The area collection process was divided into two parts:

- The first involved parking lots greater than one acre; these were individually identified and recorded for the entire region analyzed.
- The second part involved smaller parking lots. For this, we only recorded data for one representative county and projected the results to all other counties assuming

* The NYISO 2005 Report predicts significant shortfalls for the Lower Hudson Valley and Southeast NY in coming years. By 2008, an additional 500 MW will be needed due to increased demand and the retirement of existing facilities. If this demand is met, an additional 1,250 MW will be needed by 2010 and 2,250 MW by 2015. (9)

a similar size distribution. After gathering the large parking lot data for the entire area, we compared the parking lot size distribution for each county. The comparison yielded high correlation values that allowed us to extrapolate data from any one county to make accurate conclusions about all others. Nassau County was chosen as the representative county due to its size, as well as its strong correlation to all other counties (Fig. 2.)

In addition to the size and location, we also recorded the level of obstruction for each parking lot, ranging from no obstruction to major obstruction. The classifications are as follows:

- *No Obstruction*: During most of the day there are no shadows cast on the parking lot.
- *Very Little Obstruction*: This designation applies to parking with low structures or trees close to the parking lot that often just shade the edges. This often occurs in malls and large shopping centers were lots are largely open; however, the edges are slightly obstructed (0-5 % of total area.)
- *Minor Obstruction*: Parking lots with minor obstructions have structures or trees around them that block or restrict direct sunlight from hitting some of the area (5-15% of total area.)
- *Major Obstruction*: Parking lots with major obstructions have structures or trees around them that block or restrict direct sunlight from hitting a significant amount of the parking lot (>15% of total area.)

RESULTS

Parking lots greater than one acre: The results from the first collection of all lots larger than one acre are summarized in Figure 2. In total we observed 2,927 parking lots which added up to a total area of roughly 8,103 acres. With PV conversion efficiency now approaching 20%, we assumed a gross area conversion of 7% amounting to 300 kW peak per acre; the total amount of peak power that could potentially be produced on large parking lots is thus 2,431 MW. Of these lots, 31.7 % had no obstructions, 61.5 % had very little obstructions, 6.3% had minor obstructions, and .5% had major obstructions

A comparison of the size distribution of the available parking lots led to an anticipated outcome: the number of available parking lots decreased as their size increased (fig. 3a.) This distribution changes significantly when considering the potential power production from parking lots that fall within the indicated ranges (fig. 3b.) As the graph shows, the greatest contributors to the potential power production are 1.67 to 3.33 acre lots that produce between 500-1000 kW (see figure 1 for examples.)

Three main areas contain the majority of the available space; Long Island, the Albany Metro area, and in the lower Hudson River Valley (fig. 4a.) Among these counties Suffolk had the highest potential power production with 552 MW and Greene County the lowest with 9.6 MW (fig. 5.) Similar geographic distributions were found when comparing the potential power production to the total land area of each county (fig. 4b.) This comparison showed Nassau and Queens County's having the highest concentrations of parking lot space with the rest of Long Island, New York City, the Albany area, and the lower Hudson River Valley having lower, yet still significant concentrations.

Parking lots less than one acre: The second collection of all parking lots less than one acre in Nassau County resulted in 668 parking lots. These covered a total area of 333 acres providing an additional 100 MW. After extrapolation, the overall potential power production increased 516 MW resulting in a total of 2,947 MW for the entire area. Figures 6a and 6b show the overall size distribution and potential power production distribution including the extrapolated data for parking lots less than one acre.

DISCUSSION

The benefits of dispersed PV generation, grid security enhancement, peak shaving, etc., have been thoroughly explained in previous studies (1 2, 3, 4, 5.). In the present study, we present evidence that the space available on parking lots in southeastern New York State is more than adequate to fully deliver these benefits should be PV be deployed as such.

- *Demand Response/Peak Shaving Enhancement:* If utilized, the available parking lot space would provide an excellent source of peak power. Parking lots could provide almost 20% of the peak demand of southeastern NY. This capacity could be guaranteed when used in conjunction with modest demand response (DR) programs (2): it has been shown that in the downstate New York area the peak shaving potential of DR programs can be multiplied by a factor of 3 to 5, up to grid penetrations of 20%[*], by using DR calls as a guaranty of firm PV peak shaving.

- *Blackout Security:* A majority of power grid failures that affect the chosen area are caused by locally high demand driven mainly by cooling systems. This demand requires excessive amounts of power to travel long distances, often through overburdened transmission lines and substations (4.) If a component fails along the way, it can cause a catastrophic cascade of outages, as was the case during the blackout of August 14th, 2003. The presence of a dispersed PV array would drastically reduce the chances of such an event occurring again as the additional power supply would curtail local demands. It has been estimated that a few hundreds of MW of PV power around NYC and other large northeastern cities would have substantially reduced the chances of the blackout affecting the area (1.) There is enough parking lot space within NYC and adjacent counties to produce over 1300 MW.

[*] 20% penetration in NYC would represent about 2000 MW.

Given the increased concern over the impact of non-renewable energy sources, New York policy makers have taken many proactive steps to make renewable energy sources far more affordable and available. The state government has enacted several programs that offer rebates and incentives for the deployment, development and production of PV arrays and other renewable resources. In 2001, Governor George Pataki signed Executive Order 111 setting the goal of having 20% of New York's power come from renewable resources by 2010. In 2005, the New York Public Service Commission adopted a renewable portfolio standard that raised this goal to 25% by 2013. At the time of its enactment, it was estimated that 19% of the states power came from renewable resources and that an additional 3700 MW where needed to accomplish this goal (7.) The available parking lot space for PV deployment in just downstate New York would provide a substantial amount of power for the needed increase.

CONCLUSION

This study shows that 9823 acres of parking lots amounting to 2947 MW with currently achievable conversion efficiency could be available for PV deployment in southeastern New York near the State's highest load centers. This capacity corresponds to the amount of PV capacity penetration (15-20%) that could effectively be absorbed by the power grid while providing substantial peak demand relief and ideally complementing demand response programs (2.)

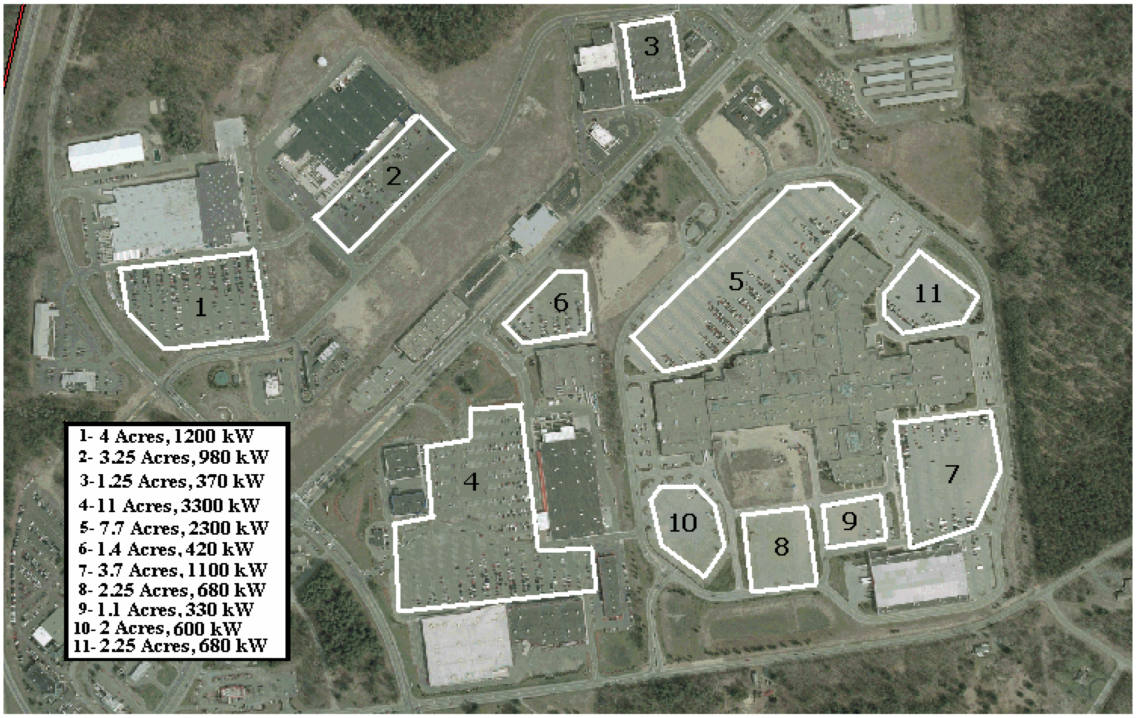
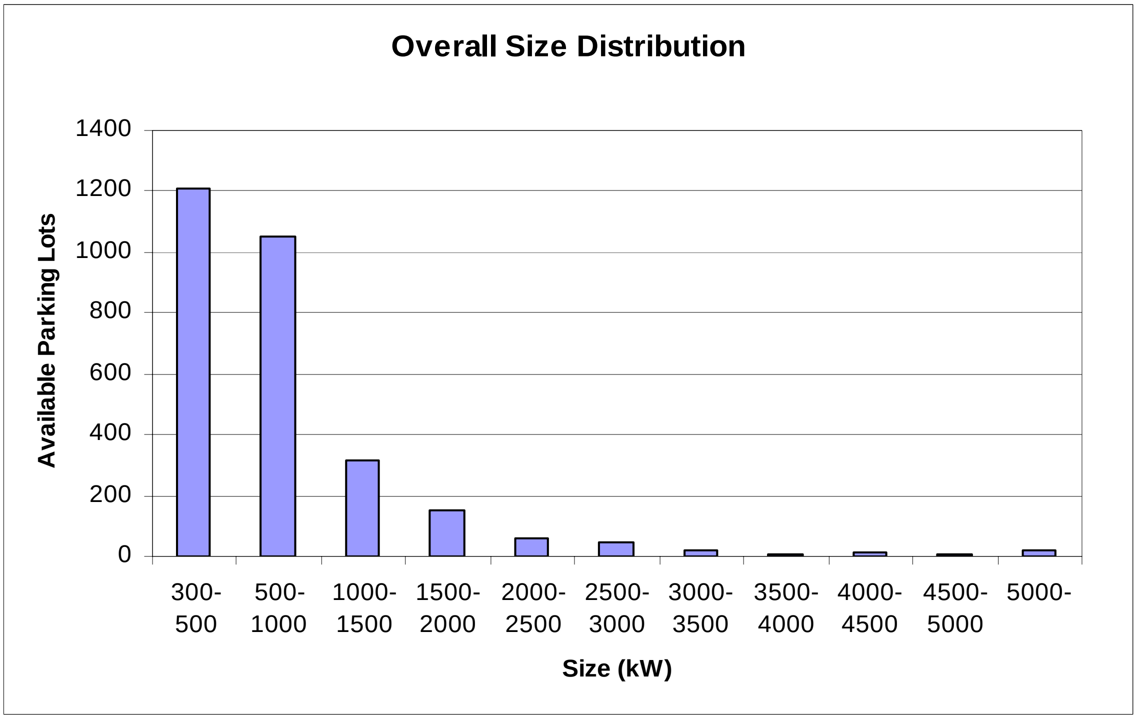


Figure 1: Image taken form the Interactive Mapping Gateway (8.) Outlined are several parking lots recorded with their relative size and potential power production displayed *(back to text)*

County:	Correlation	Percent Total
Nassau	1	20.9
Overall	0.999	100
Albany	0.997	9.39
Suffolk	0.993	22.73
Saratoga	0.993	4.15
Westchester	0.992	9.4
Schenectady	0.99	2.39
Greene	0.99	0.4
Dutchess	0.987	4.14
Rockland	0.982	4.96
Kings	0.981	1.11
Orange	0.97	5.19
Richmond	0.97	2.08
Ulster	0.967	2.36
Bronx	0.962	1.92
Rensselaer	0.945	1.47
Queens	0.941	5.97
New York	0.941	0.42
Columbia	0.939	0.53
Putnam	0.878	0.49

Figure 2: Correlation between each counties size distribution and Nassau's size distribution as well as percent of total parking lots contained in each county *(back to text)*



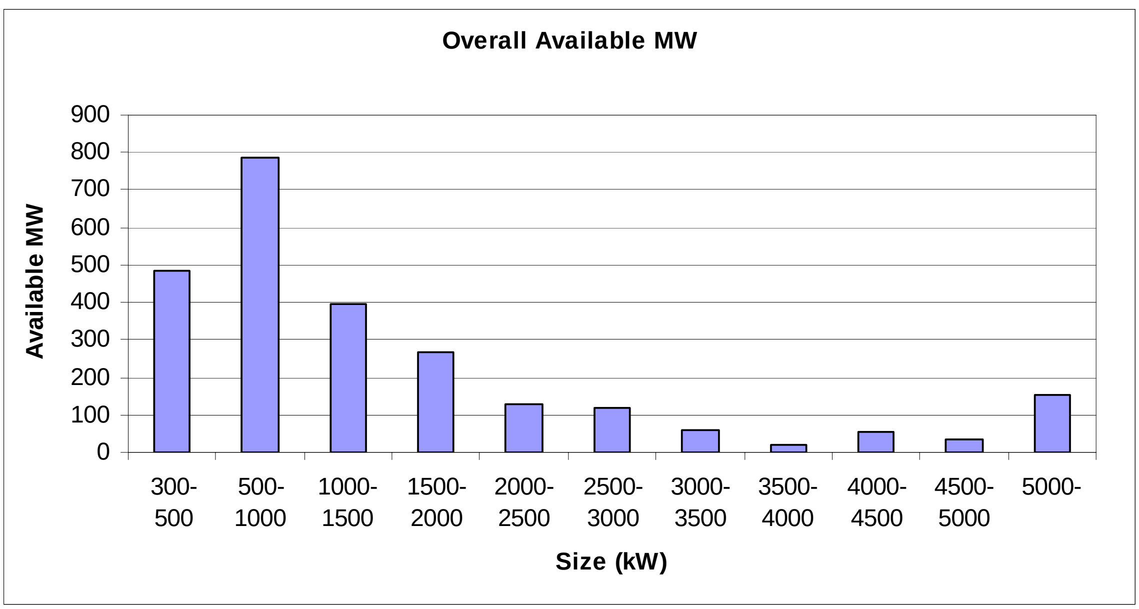
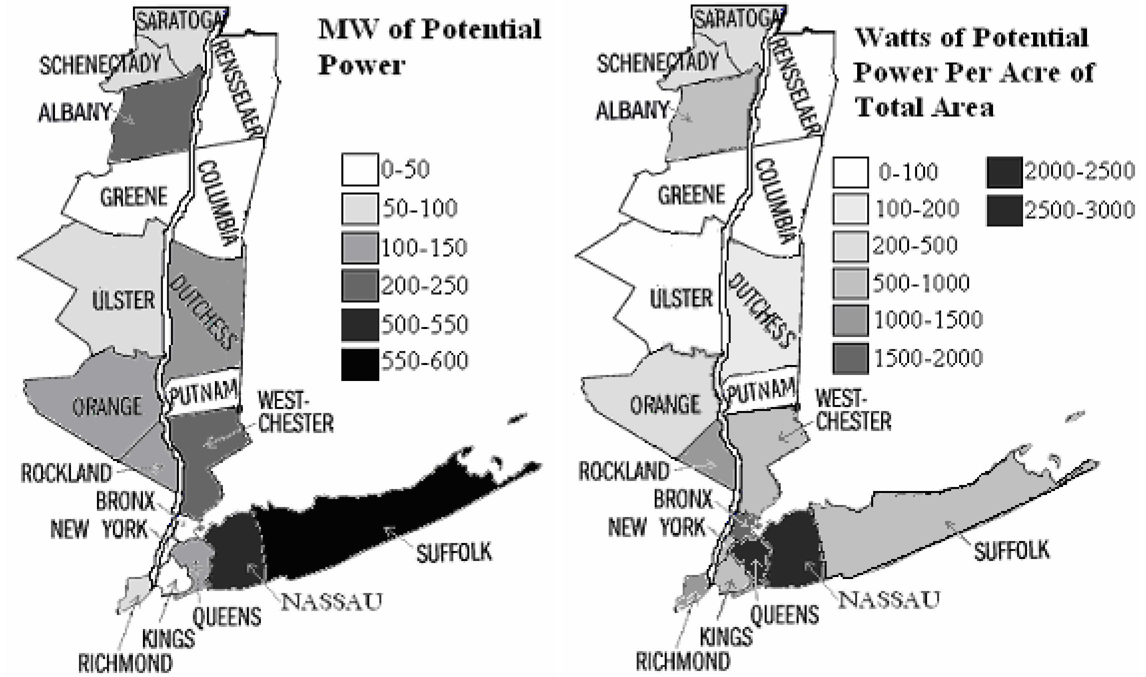


Figure 3a, 3b: The size distribution for parking lots over one acre (3a) and the potential power production (MW) of the observed parking lots (3b.). *(Back to text)*



Figures 4a, 4b: Comparison of data by county: Figure 4a compares the potential power production (MW) of all parking lots over one acre. Figure 4b compares the watts of potential power per acre of land in each county. County Map (6.)

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County:	Acres:	Megawatts:	< One Acre (MW)	County:	Acres:	Megawatts:	< One Acre (MW)
Suffolk	1842.34	552.70	114	Ulster	191.48	57.45	12
Nassau	1693.83	508.15	100	Richmond	168.93	50.68	10
Westchester	762.19	228.66	58	Bronx	155.47	46.64	9
Albany	761.03	228.31	43	Rensselaer	119.82	35.95	11
Orange	489.17	146.75	24	Kings	90.33	27.10	8
Queens	483.74	145.12	20	Columbia	42.59	12.78	3
Rockland	402.24	120.67	28	Putnam	39.42	11.83	3
Saratoga	336.14	100.84	25	New York	33.98	10.20	2
Dutchess	335.53	100.66	22	Greene	32.26	9.68	3
Schenectady	193.61	58.08	14				

Figure 5: Total acres of parking lot space as well as potential power production by county.
**The data for parking lots less than one acre was extrapolated from the Nassau County distribution.*

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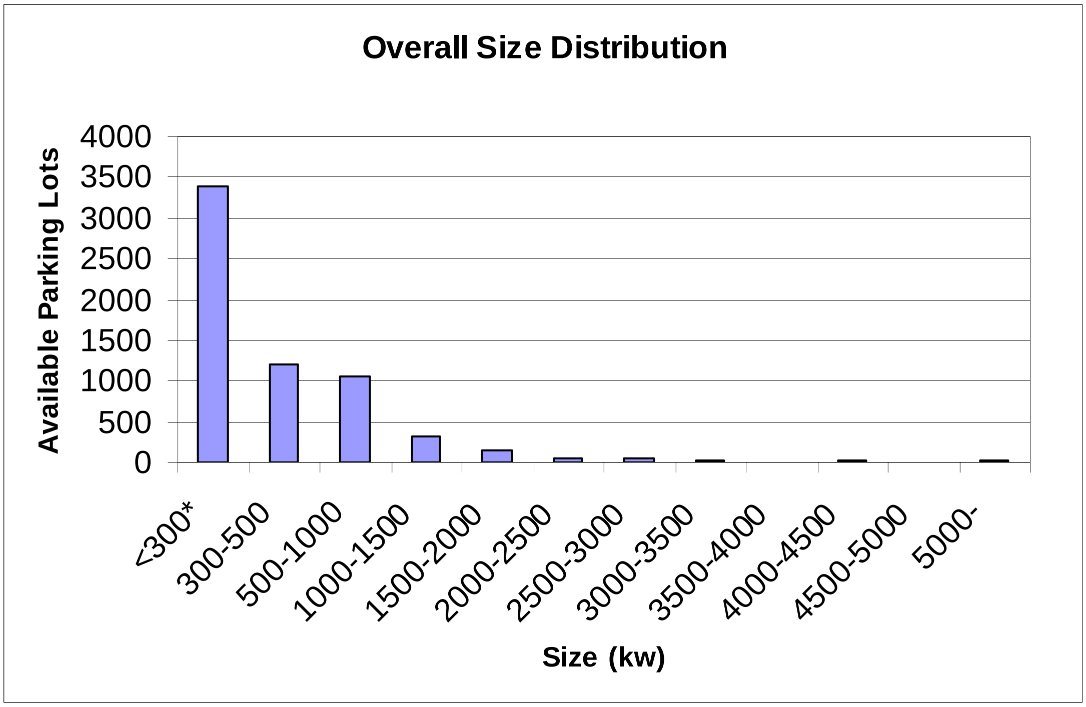

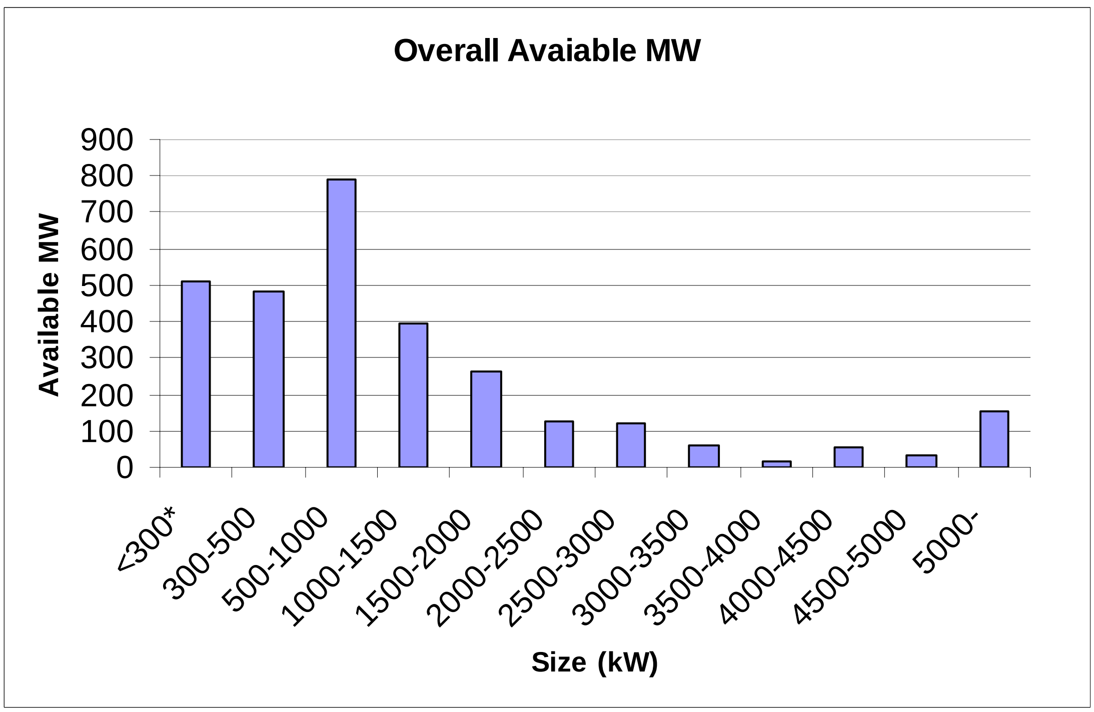

Figure 6a, 6b: The size distribution for all parking lots (3a) and the potential power production (MW) of all parking lots (3b.).
**Extrapolated*
(Back to Text)

Reference:

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