

DETERMINATION OF PHOTOVOLTAIC EFFECTIVE CAPACITY FOR NEW JERSEY

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EXECUTIVE SUMMARY

The effective capacity of a power plant represents its effective contribution to a utility's available generating capacity. Because PV plants are not controllable, their effective capacity is generally underestimated. However, there is growing evidence that, when utility demand peaks are driven by commercial air conditioning, PV may effectively contribute to the utility's available generating capacity.

The effective capacity of PV power plants operating in the service territory of the three largest New Jersey utilities was estimated by analyzing three years of hourly system load data and time/site specific solar irradiance data. The three considered utilities are:

- Public Service Electric and Gas Co. (PSEG)
- Jersey Central Power and Light Co. (JCPL)
- Atlantic Electric Co. (AECO)

Effective capacity was quantified using three complementary metrics:

- Effective Load Carrying Capability (ELCC),
- Minimum buffer Energy Storage (MBES) and
- Solar Load Control (SLC) requirements.

The ELCC metric is a statistical measure of capacity. In first approximation, this may be interpreted as percent ideal power plant equivalent¹.

The MBES and SLC quantify respectively the minimum amount of backup [stored] energy, and load shedding (via system-wide cooling temperature setpoint increase) that would be necessary to guaranty 100% ELCC.

As shown in Figure 1, The Effective Load Carrying Capability (ELCC) observed for New Jersey utilities ranges from 40% to 70% depending upon orientation and penetration. . This high value reflects the natural coincidence between the solar resource and electrical demand on the New Jersey grid. At low grid penetration, the ELCC of fixed, optimized PV installations reaches 64% for PSEG, and 62% for JCPL and 58 % for AECO.

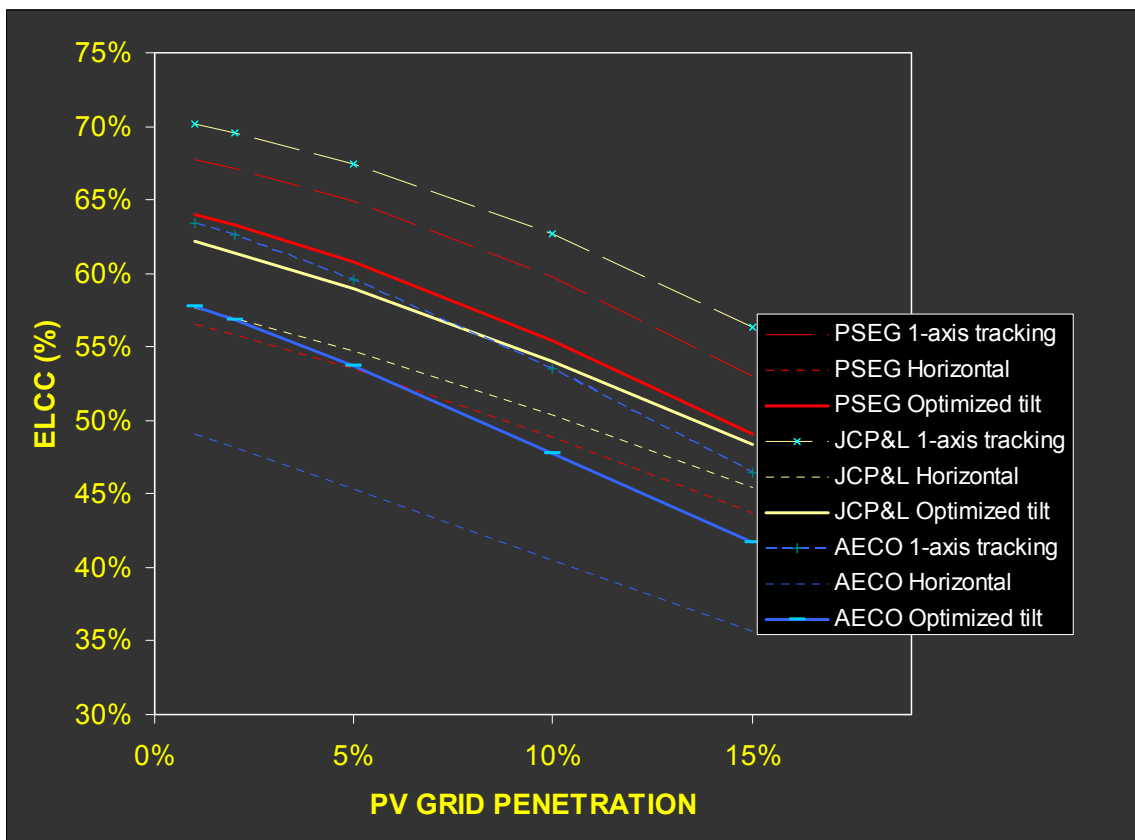


Fig. 1 ELCC as a function of PV penetration and array geometry

The other capacity metrics also reflect the strong effective capacity of PV for New Jersey (see Figure 2). For instance, at low PV penetration, it would respectively take 0.2, 0.5, and 0.7 installed capacity-hours of storage for PSEG, JCPL and AECO to supplement PV and reach 100% effective capacity. Providing the same peak load relief without PV would require four to eight times more stored energy.

¹ e.g., a 1 MW PV plant with a 70% ELCC can be considered equivalent to a 700 KW ideally dispatchable power plant.

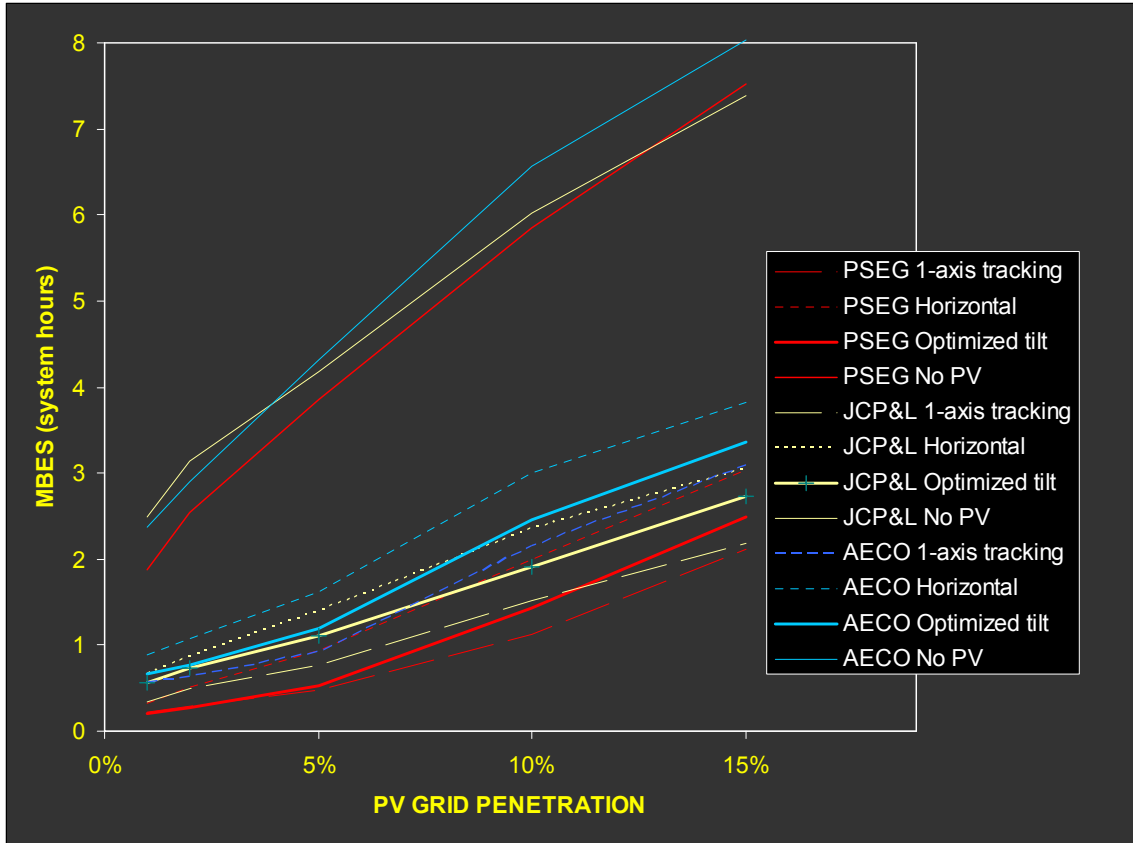


Fig. 2: MBES as a function of PV grid-penetration, array geometry compared to storage/backup requirements without PV. (See full description of MBES on Page 4, and illustrative example In foot-note no.2)

I METHODS

The effective capacity of PV was determined experimentally from hourly system load and time/site specific simulated PV output.

Three years worth of system load data were analyzed: 2000, 2001 and 2002.

Time/site-specific irradiances throughout each utility’s service area, were simulated from hourly geostationary satellite-derived irradiances [1, 2]. Operational ambient temperatures and wind-speeds were obtained from local climatological summaries.

PV simulations: we used PVFORM 4.0 for the simulations [note that PV-FORM is the engine at the basis of PV-Watts]. PV systems are specified in terms of PTC rating – i.e., delivered ac output at 25°C ambient: 1 kW of PV signifies 1-kW ac output at 25°C ambient and 1000 Wm⁻² plane of array irradiance.

The following modules and array geometries were analyzed:

- Modules: Standard crystalline modules.
- Geometries: We considered three geometries (1) 1-axis tracking with horizontal north-south axis; (2) horizontal, and (3) Fixed-tilt optimized for mid afternoon maximum output (20°-tilt and 60°-azimuth, West). The first represents nearly ideal summer power output, while the second represents common commercial roof installations.

• **Effective capacity metrics**: Three types of metrics were produced:

- Effective Load Carrying Capability (ELCC): This is a statistical measure of effective capacity. The ELCC represents the increase in capacity available to a localized grid that is attributable to the deployed PV capacity on that grid, at constant loss-of-load probability [3, 4].

ELCC is quantified in % of installed PV capacity.

The ELCC may be interpreted in terms of ideal resource equivalence; e.g., a 100 MW PV plant with a 45% ELCC may be considered as equivalent to a 45 MW fully dispatchable unit with no down-time.

- Minimum Buffer Energy Storage (MBES): This is a deterministic measure of capacity. The MBES represents the minimum amount of back-up or stored energy that would be sufficient to guaranty that all loads above a threshold, equal to peak-load minus installed PV capacity, are met by PV + storage [5]. This metric is interesting because, as a measure of the worse case situation, it removes the statistical uncertainty associated with the ELCC. In addition, it provides insight on the economic impact of guaranteeing 100% firm capacity, because it can be easily extrapolated in additional PV installed cost².

MBES is quantified in installed PV capacity-hours (*e.g.*, 0.5 hours = 50 MWh for 100 MW installed PV capacity). The MBES is contrasted to the amount of storage or backup energy that would be necessary to accomplish the same objective without PV.

- Solar Load Control Degree-Hours (SLC): Because peak loads are driven by A/C demand, it has been shown that utility-wide cooling temperature mitigation in response to critical load-PV situations [6] could, via temporary load shedding, guaranty that PV + SLC meet all loads in excess the threshold specified above, with minimal end-use temperature discomfort.

SLC is quantified in terms of (1) maximum daily °C-hours of end-user discomfort, and (2) total yearly °C-hours of user discomfort. As for MBES, these metrics are contrasted to the amount of temperature increase that would be necessary to accomplish the same objective without PV.

² For instance, 0.5 system hours at 1MW = 500 kWh; with a battery-storage cost of, e.g., \$300/kWh, guaranteeing firm PV capacity would add \$150 per installed PV kW.

Impact of PV grid-penetration: Because of utility load shape, peak load drivers, and because of the daytime-only availability of PV power, the effective capacity of PV is bound to decrease with PV grid penetration. This decrease is a direct consequence of the facts that peaks are indirectly driven by the sun (creating enhanced cooling load requirements during the hottest days). As PV penetration increases, PV capacity is no longer confined to meeting the highest peak loads, but must also address shoulder loads, and – ultimately – base loads that are not correlated with PV.

PV grid-penetrations ranging from 1% of utility peak to 15% of utility peak were considered for this study.

II RESULTS

Results presented in this section are 2000-2002 averages. Year-specific results can be found in the appendix.

PUBLIC SERVICE ELECTRIC AND GAS

As a qualitative illustration of the natural relationship existing between peak demand and PV generation, Fig. 3 illustrates load and PV output profiles³ on the 3-year period peak day, July 23, 2002.

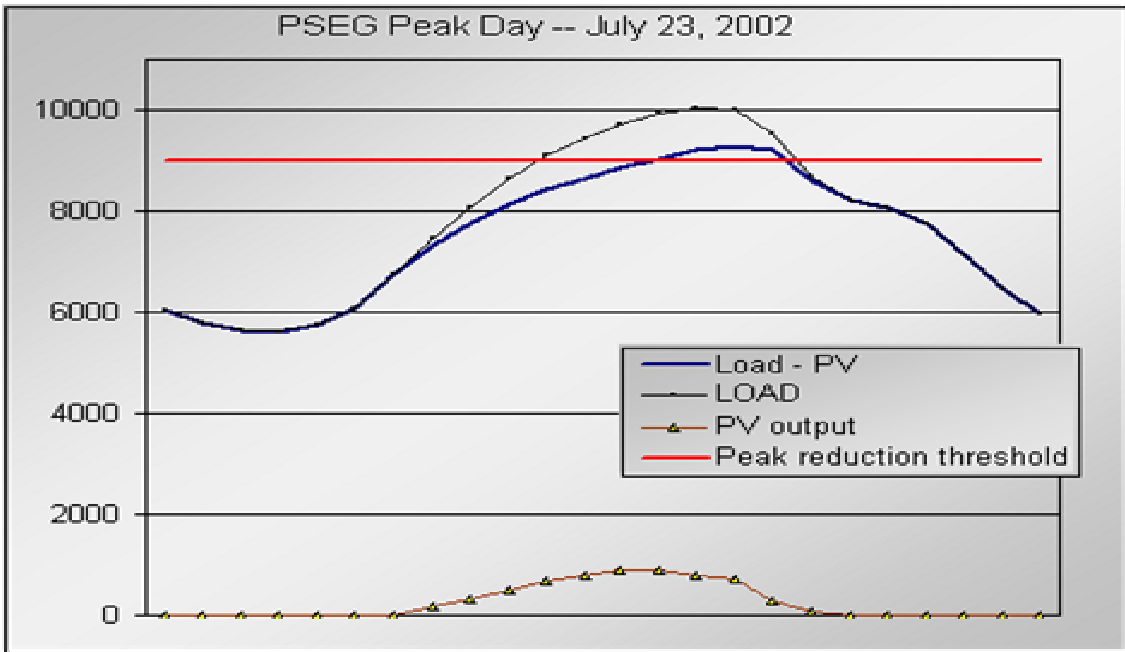


Fig. 3 – PV output³ and PSEG load on 7/23/02.

Effective capacity results using respectively ELCC, MBES and SLC as metrics, are presented in Tables 1, 2, 3 and 4. Table 3 reports the maximum one-day SLC system-wide temperature increase required to guaranty 100% PV capacity. Table 4 reports the total cumulative degree-hours required throughout the entire cooling season.

³ In Fig. 1, PV output is shown for a total installed capacity = 10% of utility peak, using 1-axis tracking geometry. The horizontal line is set at peak minus 10%. (note that the area between the horizontal line and the bold line illustrates MBES requirements).

Table 1 – ELCC for PSEG

3-YR AVERAGE	PV PENETRATION (%)				
	1%	2%	5%	10%	15%
1-axis tracking PV					
ELCC (%)	68%	67%	65%	60%	53%
Horizontal PV					
ELCC (%)	57%	56%	53%	49%	44%
20°-tilt 60°-West PV					
ELCC (%)	64%	63%	61%	55%	49%

Table 2 -- MBES for PSEG

3-YR AVERAGE	PV PENETRATION (%)				
	1%	2%	5%	10%	15%
1-axis tracking PV					
MBES (Installed PV-hours)	0.22	0.28	0.49	1.12	2.11
Horizontal PV					
MBES (Installed PV-hours)	0.32	0.51	0.94	1.99	3.04
20°-tilt 60°-West PV					
MBES (Installed PV-hours)	0.21	0.28	0.53	1.44	2.48
NO PV					
MBES (Installed PV-hours)	1.87	2.55	3.86	5.85	7.52

Table 3 -- SLC for PSEG (maximum 1-day degree-hours increase °C)

3-YR AVERAGE	PV PENETRATION (%)				
	1%	2%	5%	10%	15%
1-axis tracking PV					
SLC1 (max daily degree-hours)	0.1	0.2	1.0	4.5	12.9
Horizontal PV					
SLC1 (max daily degree-hours)	0.1	0.4	1.9	8.1	18.5
20°-tilt 60°-West PV					
SLC1 (max daily degree-hours)	0.1	0.2	1.1	5.8	15.1
NO PV					
SLC1 (max daily degree-hours)	0.8	2.1	7.9	23.7	45.9

Table 4 -- SLC for PSEG (total degree-hours increase for year °C)

3-YR AVERAGE	PV PENETRATION (%)				
	1%	2%	5%	10%	15%
1-axis tracking PV					
SLC2 (year total degree-hours)	0.1	0.2	1.0	8.8	49.3
Horizontal PV					
SLC2 (year total degree-hours)	0.1	0.4	2.6	23.2	86.4
20°-tilt 60°-West PV					
SLC2 (year total degree-hours)	0.1	0.2	1.1	13.5	63.6
NO PV					
SLC2 (year total degree-hours)	0.8	2.7	24.3	130.9	356.3

JERSEY CENTRAL POWER & LIGHT

The natural relationship existing between peak demand and PV generation for JCPL is shown in Fig. 4 for the considered period’s peak day.

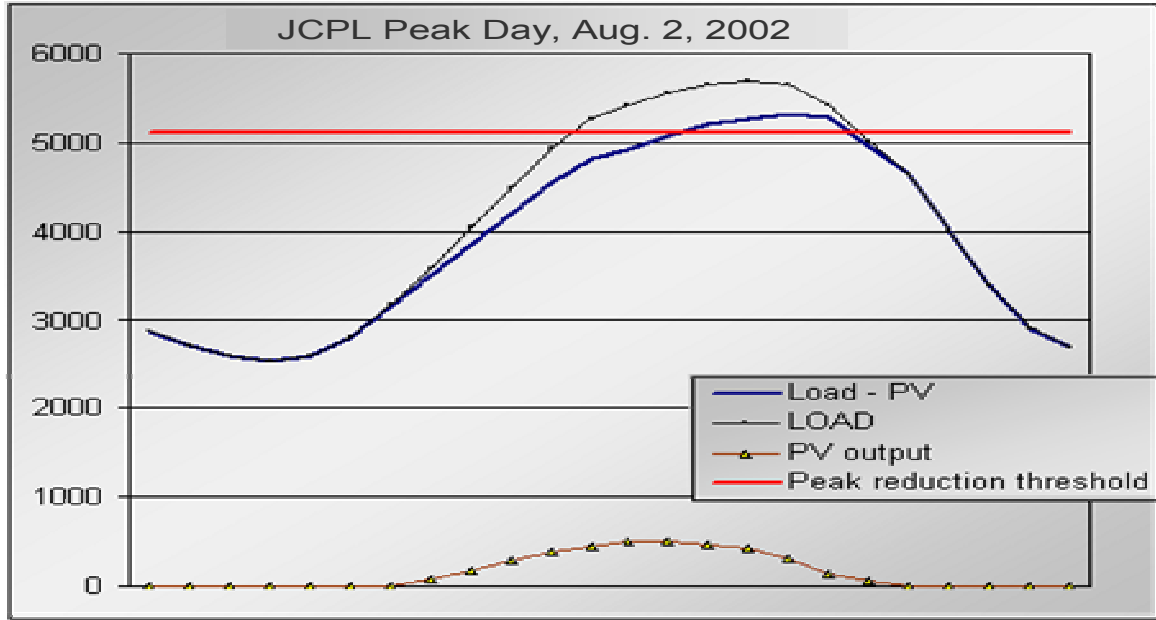


Fig. 4 – PV⁴ output and JCPL load on 7/23/02.

Effective capacity results using respectively ELCC, MBES and SLC as metrics, are presented in Tables 5, 6, 7 and 8. Table 7 reports the maximum one-day SLC system-wide temperature increase required to guaranty 100% PV capacity. Table 8 reports the total cumulative degree-hours required throughout the entire cooling season.

Table 5 – ELCC for JCPL

3-YR AVERAGE	PV PENETRATION (%)				
	1%	2%	5%	10%	15%
1-axis tracking PV					
ELCC (%)	70%	70%	67%	63%	56%
Horizontal PV					
ELCC (%)	58%	57%	55%	50%	45%
20°-tilt 60°-West PV					
ELCC (%)	62%	61%	59%	54%	48%

Table 6 -- MBES for JCPL

⁴ In Fig. 1, PV output is shown for a total installed capacity = 10% of utility peak, using 1-axis tracking geometry. The horizontal line is set at peak minus 10%. (note that the area between the horizontal line and the bold line illustrates MBES requirements).

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3-YR AVERAGE	PV PENETRATION (%)				
	1%	2%	5%	10%	15%
1-axis tracking PV					
MBES (Installed PV-hours)	0.34	0.50	0.76	1.51	2.19
Horizontal PV					
MBES (Installed PV-hours)	0.66	0.87	1.40	2.36	3.05
20°-tilt 60°-West PV					
MBES (Installed PV-hours)	0.56	0.73	1.10	1.91	2.73
NO PV					
MBES (Installed PV-hours)	2.50	3.14	4.18	6.02	7.39

Table 7 -- SLC for JCPL (maximum 1-day degree-hours increase °C)

3-YR AVERAGE	PV PENETRATION (%)				
	1%	2%	5%	10%	15%
1-axis tracking PV					
SLC1 (max daily degree-hours)	0.1	0.3	1.0	4.0	8.7
Horizontal PV					
SLC1 (max daily degree-hours)	0.2	0.5	1.9	6.3	12.2
20°-tilt 60°-West PV					
SLC1 (max daily degree-hours)	0.1	0.4	1.5	5.1	11.0
NO PV					
SLC1 (max daily degree-hours)	0.7	1.7	5.6	16.1	29.7

Table 8 -- SLC for JCPL (total degree-hours increase for year °C)

3-YR AVERAGE	PV PENETRATION (%)				
	1%	2%	5%	10%	15%
1-axis tracking PV					
SLC2 (year total degree-hours)	0.1	0.3	1.3	8.3	27.0
Horizontal PV					
SLC2 (year total degree-hours)	0.2	0.5	3.2	17.6	49.7
20°-tilt 60°-West PV					
SLC2 (year total degree-hours)	0.1	0.4	2.4	13.9	43.8
NO PV					
SLC2 (year total degree-hours)	0.9	3.2	18.5	81.7	212.3

ATLANTIC ELECTRIC COMPANY

The natural relationship existing between peak demand and PV generation for AECO is shown in Fig. 5 for the considered period's peak day.

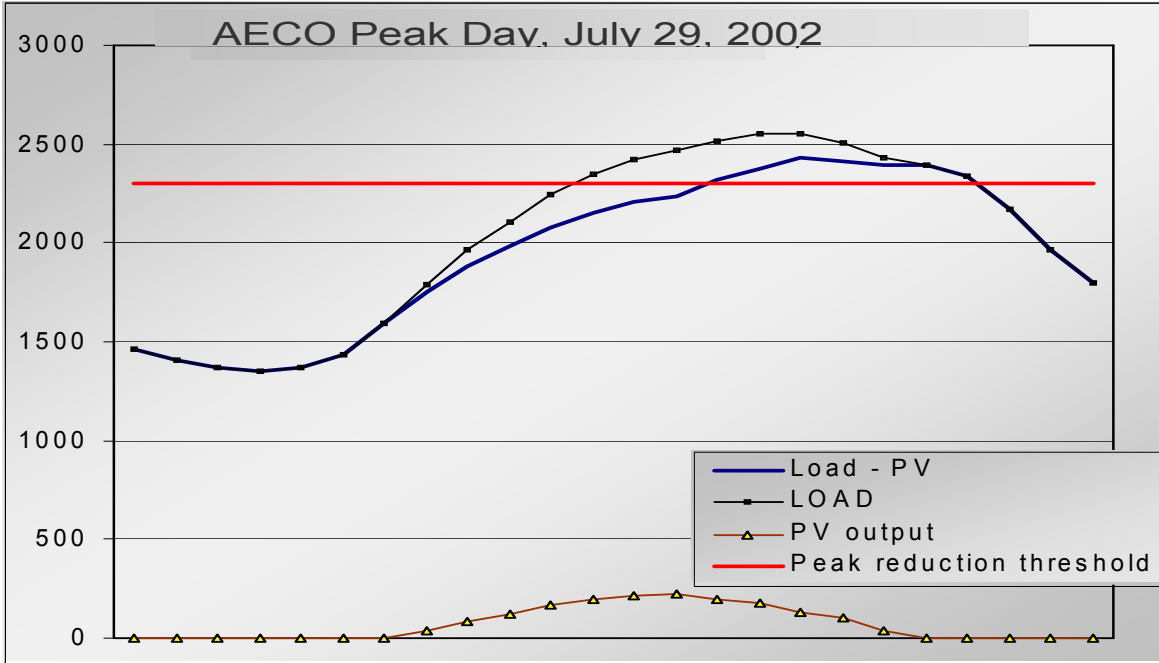


Fig. 5 – PV⁵ output and AECO load on 7/23/02.

Effective capacity results using respectively ELCC, MBES and SLC as metrics, are presented in Tables 9, 10, 11 and 12. Table 11 reports the maximum one-day SLC system-wide temperature increase required to guaranty 100% PV capacity. Table 12 reports the total cumulative degree-hours required throughout the entire cooling season.

Table 9 – ELCC for AECO

3-YR AVERAGE	PV PENETRATION (%)				
	1%	2%	5%	10%	15%
1-axis tracking PV					
ELCC (%)	63%	63%	60%	53%	46%
Horizontal PV					
ELCC (%)	49%	48%	45%	40%	36%
20°-tilt 60°-West PV					
ELCC (%)	58%	57%	54%	48%	42%

⁵ In Fig. 1, PV output is shown for a total installed capacity = 10% of utility peak, using 1-axis tracking geometry. The horizontal line is set at peak minus 10% (note that the area between the horizontal line and the bold line illustrates MBES requirements).

Table 10 -- MBES for AECO

3-YR AVERAGE	PV PENETRATION (%)				
	1%	2%	5%	10%	15%
1-axis tracking PV					
MBES (Installed PV-hours)	0.56	0.63	0.92	2.15	3.09
Horizontal PV					
MBES (Installed PV-hours)	0.88	1.08	1.62	3.01	3.83
20°-tilt 60°-West PV					
MBES (Installed PV-hours)	0.66	0.78	1.19	2.46	3.35
NO PV					
MBES (Installed PV-hours)	2.36	2.90	4.32	6.57	8.04

Table 11 -- SLC for AECO (maximum 1-day degree-hours increase °C)

3-YR AVERAGE	PV PENETRATION (%)				
	1%	2%	5%	10%	15%
1-axis tracking PV					
SLC1 (max daily degree-hours)	0.2	0.4	1.5	7.3	15.7
Horizontal PV					
SLC1 (max daily degree-hours)	0.3	0.7	2.8	10.3	19.6
20°-tilt 60°-West PV					
SLC1 (max daily degree-hours)	0.2	0.5	2.0	8.4	17.1
NO PV					
SLC1 (max daily degree-hours)	0.8	2.0	7.4	22.5	41.3

Table 12 -- SLC for AECO (total degree-hours increase for year °C)

3-YR AVERAGE	PV PENETRATION (%)				
	1%	2%	5%	10%	15%
1-axis tracking PV					
SLC2 (year total degree-hours)	0.2	0.5	2.1	11.4	35.2
Horizontal PV					
SLC2 (year total degree-hours)	0.3	0.8	4.0	20.4	60.1
20°-tilt 60°-West PV					
SLC2 (year total degree-hours)	0.2	0.6	2.7	15.0	45.2
NO PV					
SLC2 (year total degree-hours)	0.9	2.4	13.6	72.5	229.9

III DISCUSSION

Results show that the ELCC of PV power generation is substantial in New Jersey. For the two largest utilities, ELCC reaches 70% at low grid penetration for ideal 1-axis tracking installations and 65% for optimized fixed installations. The ELCC of horizontal systems approaches 60%.

ELCC decreases with increased PV grid penetration. This is understandable since, as penetration increases, PV must meet shoulder loads which are not as well correlated with the solar resource as peak loads. However, values remain high even at considerable levels of penetration. For instance at 10% PV penetration (*i.e.*, representing 1 GW installed PV for PSEG), ELCCs for 1-axis tracking, fixed-optimized and horizontal PV still reach respectively 60%, 55% and 50%. While ELCCs remain noteworthy, values are 5-10% lower for Atlantic Electric because of its more pronounced evening shoulder load.

Considering the MBES effective capacity metric, results show that, at low PV penetration, it would take little energy storage to increase ELCC levels to 100%: respectively 0.2, 0.2, and 0.3 system-hours for the tracking, the optimized fixed, and the horizontal array for PSEG. Meeting the same peak load requirements without PV would require 8 times more backup/storage of energy. For JCP&L and AECO, MBES requirements would be ~ 2-2.5 times higher than for PSEG, but would still represent 4-5 less storage than would be needed to achieve the same peak load relief without PV.

The SLC metric indicates that minor system-wide cooling temperature increase could maximize the effective capacity of PV, even when considering substantial PV penetration levels. For instance, a total seasonal end-user discomfort of 14 degree-hours could guaranty the equivalent of firm PV capacity (for fixed-optimized arrays) at 10% PV penetration in JCPL territory.

Finally, results show that year-to-year variability is small (see tables in Appendix) and that effective capacity numbers stay consistent over time, reflecting a robust relationship between peak loads and solar gain.

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**APPENDIX
YEAR & SITE-SPECIFIC RESULTS**

Table A-1 ELCC for PSEG

	PV PENETRATION (%)				
	1%	2%	5%	10%	15%
1-axis tracking PV					
ELCC (%) 2000	65%	65%	63%	59%	54%
ELCC (%) 2001	69%	68%	65%	59%	51%
ELCC (%) 2002	69%	69%	66%	61%	55%
Horizontal PV					
ELCC (%) 2000	55%	55%	53%	49%	45%
ELCC (%) 2001	57%	56%	53%	48%	42%
ELCC (%) 2002	57%	56%	54%	50%	44%
20o-tilt 60o-West PV					
ELCC (%) 2000	62%	62%	60%	55%	50%
ELCC (%) 2001	64%	63%	60%	54%	47%
ELCC (%) 2002	66%	65%	62%	57%	50%

Table A-2 ELCC for JCP&L

	PV PENETRATION (%)				
	1%	2%	5%	10%	15%
1-axis tracking PV					
ELCC (%) 2000	69%	68%	66%	61%	54%
ELCC (%) 2001	67%	67%	64%	58%	51%
ELCC (%) 2002	74%	74%	72%	69%	64%
Horizontal PV					
ELCC (%) 2000	59%	58%	56%	52%	47%
ELCC (%) 2001	53%	52%	50%	45%	39%
ELCC (%) 2002	61%	61%	59%	55%	50%
20o-tilt 60o-West PV					
ELCC (%) 2000	59%	59%	57%	53%	48%
ELCC (%) 2001	62%	61%	58%	52%	46%
ELCC (%) 2002	65%	64%	62%	57%	51%

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Table A-3 ELCC for AECO

1-axis tracking PV					
ELCC (%) 2000	59%	57%	54%	47%	40%
ELCC (%) 2001	65%	64%	61%	55%	48%
ELCC (%) 2002	67%	66%	64%	58%	51%
Horizontal PV					
ELCC (%) 2000	46%	45%	42%	37%	33%
ELCC (%) 2001	51%	50%	47%	42%	36%
ELCC (%) 2002	50%	50%	47%	42%	38%
20o-tilt 60o-West PV					
ELCC (%) 2000	54%	53%	49%	43%	37%
ELCC (%) 2001	59%	58%	55%	49%	43%
ELCC (%) 2002	60%	59%	56%	51%	45%

Table A-4 MBES for PSEG

	PV PENETRATION (%)				
	1%	2%	5%	10%	15%
1-axis tracking PV					
MBES (Installed PV-hours) 2000	0.23	0.25	0.48	0.92	1.89
MBES (Installed PV-hours) 2001	0.20	0.28	0.48	1.71	2.79
MBES (Installed PV-hours) 2002	0.24	0.32	0.50	0.73	1.66
Horizontal PV					
MBES (Installed PV-hours) 2000	0.33	0.48	0.91	1.55	2.59
MBES (Installed PV-hours) 2001	0.27	0.44	0.95	2.86	3.95
MBES (Installed PV-hours) 2002	0.37	0.61	0.95	1.56	2.58
20°-tilt 60°-West PV					
MBES (Installed PV-hours) 2000	0.24	0.30	0.59	1.16	2.17
MBES (Installed PV-hours) 2001	0.16	0.25	0.48	2.17	3.28
MBES (Installed PV-hours) 2002	0.24	0.28	0.54	0.99	2.00
NO PV					
MBES (Installed PV-hours) 2000	1.29	2.02	3.44	5.06	6.88
MBES (Installed PV-hours) 2001	2.23	3.07	4.54	7.44	9.03
MBES (Installed PV-hours) 2002	2.09	2.54	3.61	5.04	6.65

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Table A-5 MBES for JCP&L

	PV PENETRATION (%)				
	1%	2%	5%	10%	15%
1-axis tracking PV					
MBES (Installed PV-hours) 2000	0.56	0.79	1.17	1.89	2.45
MBES (Installed PV-hours) 2001	0.31	0.55	0.90	2.31	3.03
MBES (Installed PV-hours) 2002	0.15	0.15	0.22	0.34	1.10
Horizontal PV					
MBES (Installed PV-hours) 2000	0.77	1.00	1.55	2.27	2.82
MBES (Installed PV-hours) 2001	0.95	1.24	2.06	3.47	4.18
MBES (Installed PV-hours) 2002	0.25	0.37	0.60	1.34	2.14
20°-tilt 60°-West PV					
MBES (Installed PV-hours) 2000	0.88	1.11	1.26	1.62	2.40
MBES (Installed PV-hours) 2001	0.54	0.77	1.40	2.77	3.49
MBES (Installed PV-hours) 2002	0.26	0.32	0.64	1.34	2.31
NO PV					
MBES (Installed PV-hours) 2000	2.55	3.17	3.78	5.27	6.72
MBES (Installed PV-hours) 2001	3.18	3.88	5.35	7.35	8.56
MBES (Installed PV-hours) 2002	1.77	2.38	3.42	5.44	6.88

Table A-6 MBES for AECO

	PV PENETRATION (%)				
	1%	2%	5%	10%	15%
1-axis tracking PV					
MBES (Installed PV-hours) 2000	0.84	0.95	1.45	2.91	3.73
MBES (Installed PV-hours) 2001	0.21	0.31	0.66	1.81	3.02
MBES (Installed PV-hours) 2002	0.62	0.62	0.66	1.74	2.50
Horizontal PV					
MBES (Installed PV-hours) 2000	1.03	1.21	1.77	3.28	4.10
MBES (Installed PV-hours) 2001	0.59	1.00	1.64	2.95	3.82
MBES (Installed PV-hours) 2002	1.03	1.04	1.45	2.80	3.56
20°-tilt 60°-West PV					
MBES (Installed PV-hours) 2000	0.90	1.01	1.51	2.94	3.76
MBES (Installed PV-hours) 2001	0.30	0.52	1.01	2.21	3.29
MBES (Installed PV-hours) 2002	0.79	0.80	1.04	2.24	3.00
NO PV					
MBES (Installed PV-hours) 2000	2.28	2.90	4.21	6.50	7.95
MBES (Installed PV-hours) 2001	2.83	3.53	5.09	7.21	8.65
MBES (Installed PV-hours) 2002	1.98	2.29	3.66	6.00	7.52

Table A-7 Total Seasonal SLC degree-hours for PSEG

	PV PENETRATION (%)				
	1%	2%	5%	10%	15%
1-axis tracking PV					
SLC (year total degree-hours) 2000	0.1	0.2	1.0	4.6	26.8
SLC (year total degree-hours) 2001	0.08	0.22	0.95	15.20	55.83
SLC (year total degree-hours) 2002	0.1	0.3	1.0	6.7	65.4
Horizontal PV					
SLC (year total degree-hours) 2000	0.1	0.4	1.9	11.1	44.8
SLC (year total degree-hours) 2001	0.1	0.3	3.0	31.4	88.6
SLC (year total degree-hours) 2002	0.2	0.5	2.8	27.0	125.8
20o-tilt 60o-West PV					
SLC (year total degree-hours) 2000	0.1	0.3	1.2	6.4	32.8
SLC (year total degree-hours) 2001	0.1	0.2	1.1	21.4	70.4
SLC (year total degree-hours) 2002	0.1	0.2	1.1	12.7	87.7
NO PV					
SLC (year total degree-hours) 2000	0.5	1.7	12.5	74.1	237.1
SLC (year total degree-hours) 2001	0.9	3.6	28.1	123.7	296.4
SLC (year total degree-hours) 2002	0.8	2.9	32.4	195.0	535.4

Table A-8 Total Seasonal SLC degree-hours for JCP&L

	PV PENETRATION (%)				
	1%	2%	5%	10%	15%
1-axis tracking PV					
SLC (year total degree-hours) 2000	0.1	0.4	1.5	8.3	23.1
SLC (year total degree-hours) 2001	0.08	0.30	1.79	12.75	32.48
SLC (year total degree-hours) 2002	0.0	0.1	0.5	3.7	25.4
Horizontal PV					
SLC (year total degree-hours) 2000	0.2	0.5	2.6	13.8	36.2
SLC (year total degree-hours) 2001	0.3	0.7	5.0	22.4	51.6
SLC (year total degree-hours) 2002	0.1	0.3	1.9	16.6	61.1
20o-tilt 60o-West PV					
SLC (year total degree-hours) 2000	0.2	0.6	2.7	11.5	36.2
SLC (year total degree-hours) 2001	0.1	0.4	2.8	16.7	39.8
SLC (year total degree-hours) 2002	0.1	0.2	1.8	13.6	55.5
NO PV					
SLC (year total degree-hours) 2000	0.8	2.8	14.3	60.0	166.5
SLC (year total degree-hours) 2001	1.0	3.7	18.6	67.5	148.9
SLC (year total degree-hours) 2002	0.8	3.1	22.6	117.7	321.5

Table A-9 Total Seasonal SLC degree-hours for AECO

	PV PENETRATION (%)				
	1%	2%	5%	10%	15%
1-axis tracking PV					
SLC (year total degree-hours) 2000	0.3	0.7	3.1	15.5	41.3
SLC (year total degree-hours) 2001	0.07	0.23	1.92	12.25	32.61
SLC (year total degree-hours) 2002	0.2	0.5	1.2	6.5	31.7
Horizontal PV					
SLC (year total degree-hours) 2000	0.4	1.1	5.2	22.6	57.1
SLC (year total degree-hours) 2001	0.2	0.7	4.1	20.8	52.2
SLC (year total degree-hours) 2002	0.4	0.8	2.7	18.0	70.9
20o-tilt 60o-West PV					
SLC (year total degree-hours) 2000	0.3	0.8	3.7	18.2	46.8
SLC (year total degree-hours) 2001	0.1	0.4	2.6	15.6	40.4
SLC (year total degree-hours) 2002	0.3	0.6	1.9	11.1	48.3
NO PV					
SLC (year total degree-hours) 2000	0.9	3.0	14.5	60.1	183.2
SLC (year total degree-hours) 2001	1.0	2.7	14.5	64.6	158.7
SLC (year total degree-hours) 2002	0.7	1.7	11.9	92.8	347.8