Shine On, Shine On: Persistence Analysis of New York State's Customer-Sited Solar PV Installations

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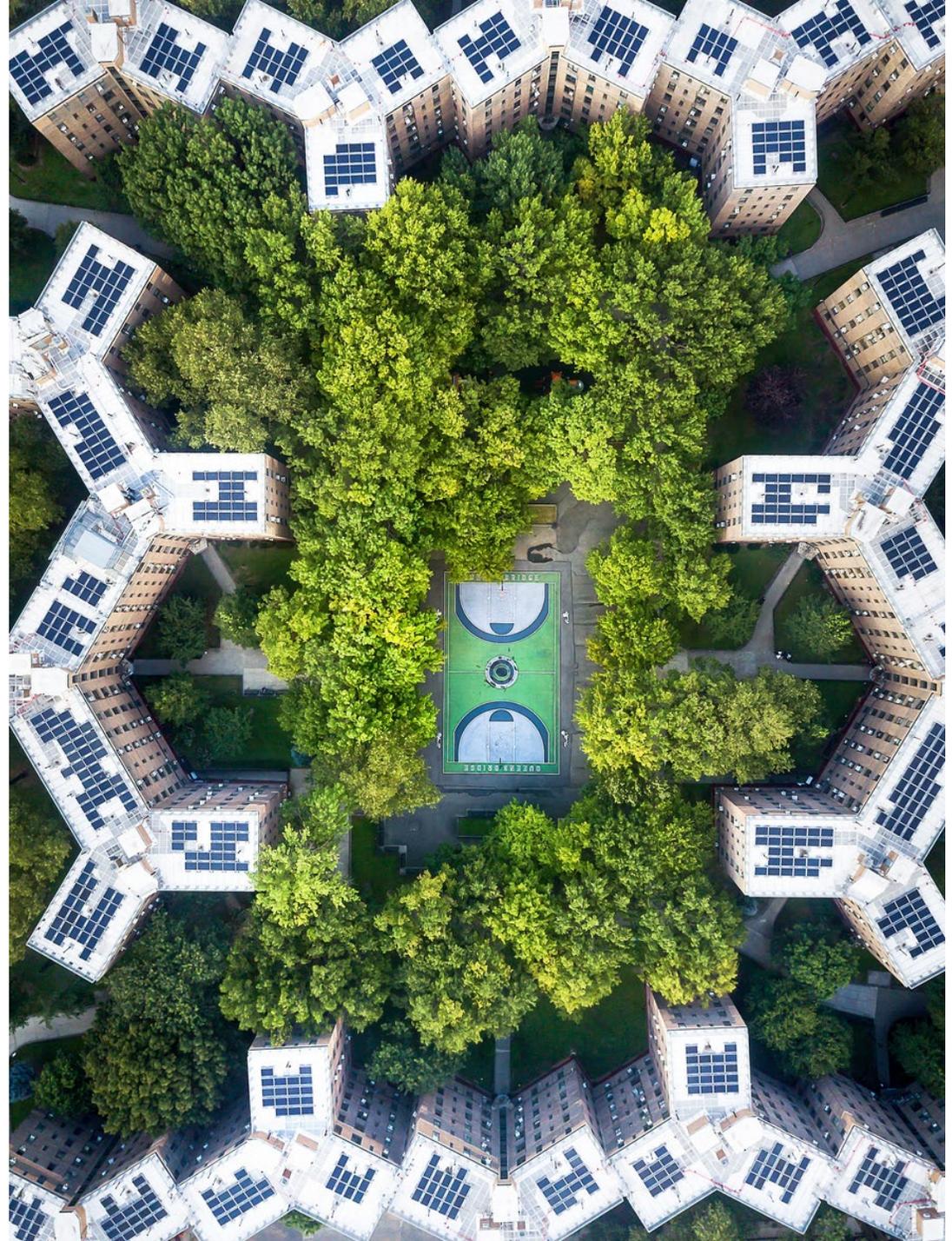Dana Nilsson, NYSERDA, Albany NY

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October 2025

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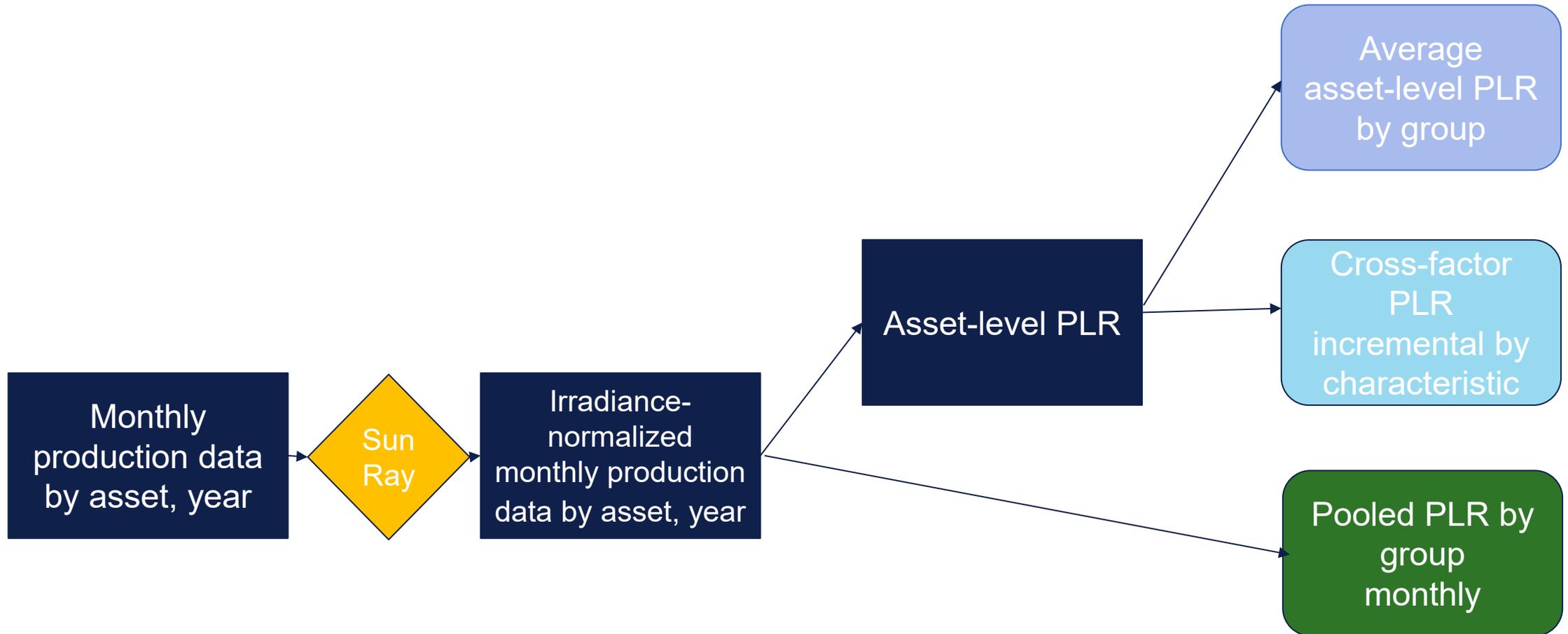
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Introduction

Study objectives

- The NYSERDA NY-Sun PV Incentive Program provides cash incentives and/or financing, with a total install goal of 10 GW by 2030.

- **Study Goal: Assess the persistence of solar production over time, and how it varies by characteristics of solar assets installed under NYSERDA's NY-Sun program from February 2012 through November 2021.**

- Persistence is assessed in terms of the **performance loss rate (PLR),** i.e. the year-over-year percentage reduction in weather-normalized annual production.

Approach

Approach to Performance Loss Rate (PLR) estimation

Monthly production data by asset, year → Sun Ray → Irradiance-normalized monthly production data by asset, year → Asset-level PLR → Average asset-level PLR by group; Cross-factor PLR incremental by characteristic; Pooled PLR by group monthly

Data

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The analysis includes a large number of cases with up to 6 years of data

Number of projects in the analysis after disruption exclusions by years of data since installation

Sector	Size (kW)	1	2	3	4	5	6	7	8	9	10	11	12
	<200	63	63	56	49	39	19	10	6	2	2	1	0
	200–750	139	139	135	120	99	90	66	42	24	13	3	0
Non-residential	≥750	79	79	76	74	67	60	38	17	7	2	0	0
Residential	All	11,249	8,976	7,834	6,722	5,015	1,208	231	88	68	52	50	47
Total	All	11,530	9,257	8,101	6,965	5,220	1,377	345	153	101	69	54	47

Results

Overall statewide PLR is at the high end of prior non-NYS findings, driven by particularly high Upstate PLR

- Prior work identifies system degradation rates generally in the range of 0.4% to 0.8% per year, across various studies and regions.

- A general value of 0.64% per year is recommended there, with exceptions for certain specific technologies.

- This study finds an average PLR of 0.8% per year,
  - Using pooled monthly PLR weighted by monthly capacity factor.
  - Higher than benchmark PLR is driven by the Upstate result.

Average Annual PLR

Benchmark	All	Downstate	Long Island	Upstate
0.6%	0.8%	0.9%	0.4%	1.7%
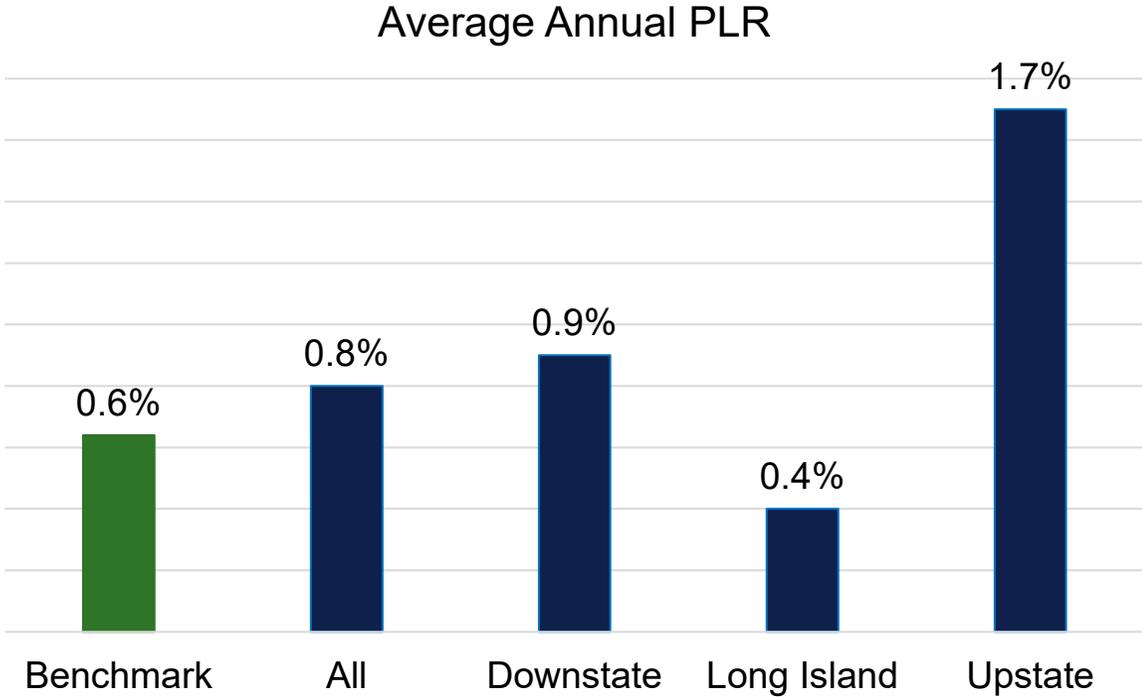
PLR Varies by DAC status, purchase type, module family, and inverter type

DAC Location

Projects in DAC locations are associated with higher PLR

Purchase type

PPA and purchased have a much higher PLR than Leased

Module family

Monocrystalline modules show minimal PLR

Inverter type

Microinverters have higher a PLR than String and Optimizer inverters

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Longer-Term Persistence

Overall system life: 30 years with proper maintenance

String inverter failures

EUL: 10-15 years. System becomes unable to convert DC to AC and goes out of commission.

Microinverter and optimizer failures

Installed at module level, therefore, less impact on system. Will reduce system output proportionally.

Communication failures

Cannot know if issue is specific to communications, or if system is not producing.

Roof repair

Installers should install PV systems only on roofs <10 years old, so reroofing is not needed during life of system

Shading

Energy forecasts assume shade scene will not change; however, trees grow, increasing shade and decreasing production

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Conclusions

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PLR overall

An overall performance loss rate of 0.83% per year is estimated across assets in New York State.

- somewhat higher than the range used by NY Green Bank.

- well within the range found in prior studies elsewhere.

Over the life of the systems, 0.83% per year PLR would decrease NYS annual production by ~20% by 2050, or ~2,200 GWh per year, out of >11,000 GWh of first-year production.

Longer-term and expanded PLR investigations

NYSERDA is continuing to collect production data, to establish a larger data set of longer production records that can be used for further study of PLR at greater ages.

Addition possible studies

- investigate the proportions of incentivized systems that are still operational at different ages.
- follow up with customers and owners of residential systems, to explore maintenance practices and approaches that might help improve these.

Thank you

For questions, please contact:

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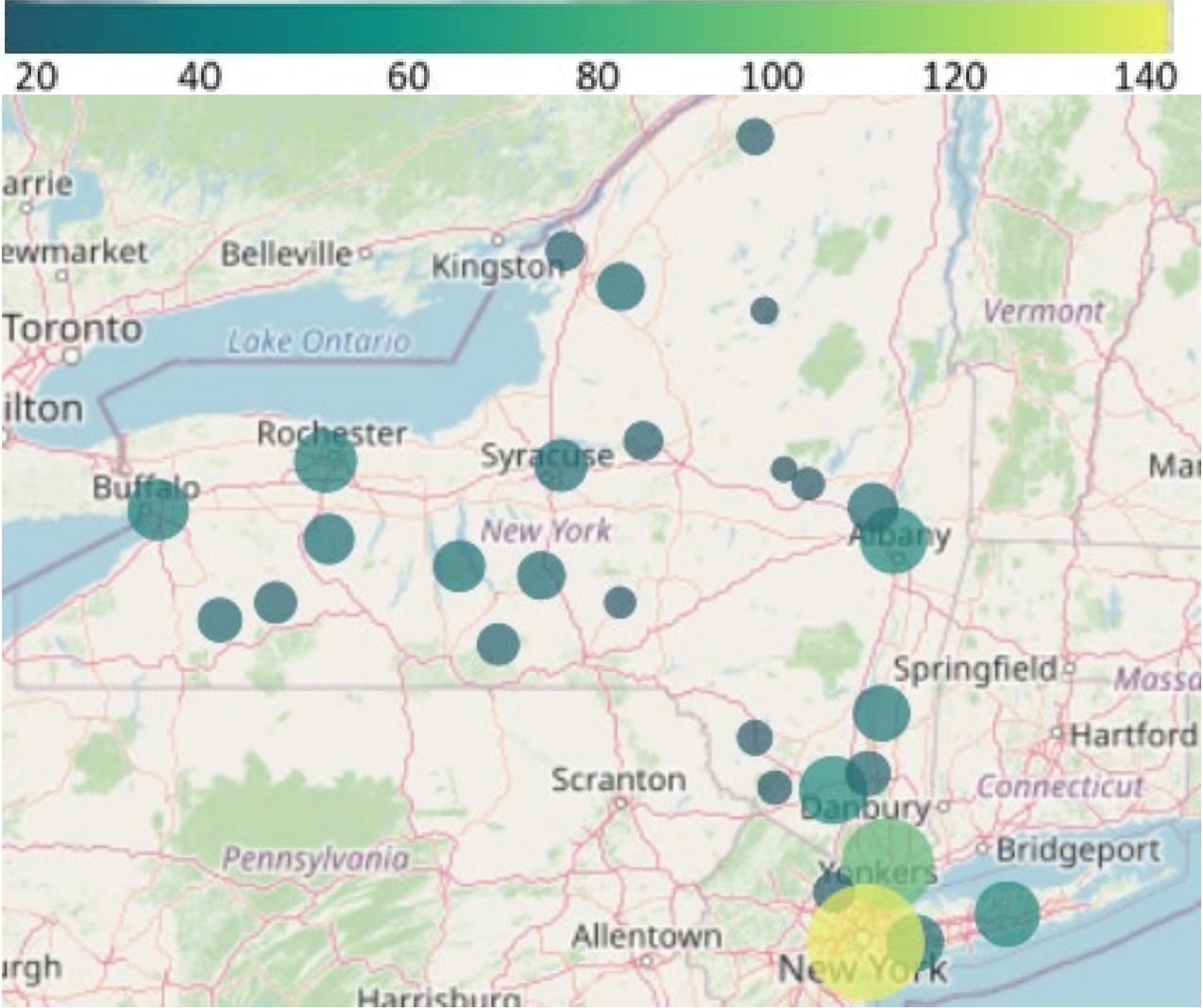miriam.goldberg@dnv.com

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Appendix

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Radiation data cluster analysis

Previous benchmarks

| Author	Ref	Year	Total (MW)	Total systems	Module vintage	Technology	System-level degradation per year (P50)
Jordan	17	2016	<10	384	<2014	2 and 3BB multi Al-BSF	-0.64%
DNV internal		2017	~80	216	2009-2013	SunPower IBC	-0.25%
Jordan	3	2018		264	2006-2011	SunPower IBC	-0.20%
Jordan	3	2018		143	2006-2011	Multi	-0.83%
Deline	18	2020	1,300	1500	2013-2018	60% multi, 30% mono	-0.72%
Newmiller	19	2020	~61	122	2010-2018	3BB multi Al-BSF	-0.74%
Jimenez	20	2020	400	87	2008-2013	3BB multi Al-BSF	-0.46%
Jordan	21	2021		1832	2013-2019	Mono Si	-0.68%
Lindig	22	2021	~2.1	361	2009-2018	Mixed	-0.67%
Deline	23	2021	~2,000	~800	2013-2019	Mixed	-0.62%
Bolinger	24	2022	31,000	631	2007-2018	multi and mono	-1.20%
Jordan	25	2022	7,200	1700	2013-2020	multi and mono	-0.75%
Theristis	26	2022	0.25		2017	multi and mono	-0.58%
DNV internal		2022	920	12	Series 3, 4, & 6	Series 6 CdTe	-0.42%
Louwen	27	2024	20,000	10,000	2008-2021	multi and mono	-0.72%
DNV internal		2024	417	54	2017-2019	multi and mono	-0.40%

Monthly Capacity Factor Calculation

Capacity factor (CF) for a given asset is calculated as:

$$CF = \frac{kWh\_eval}{CAP \times days\ in\ Month \times 24\ hours\ per\ day}$$
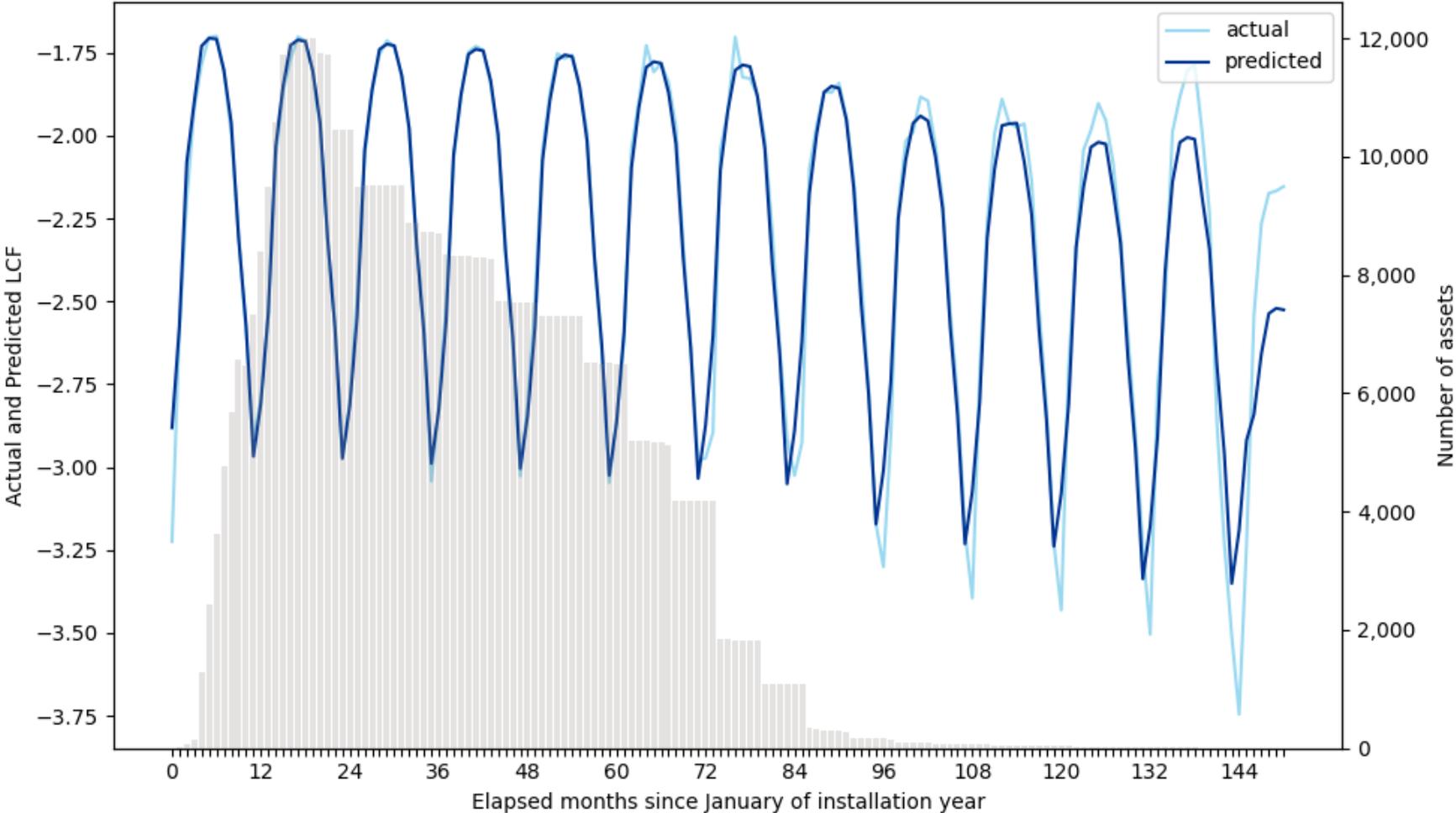
Where:

- kWh_eval = monthly production for a system (kWh)
- CAP = System rated DC capacity

Average CF by month and region
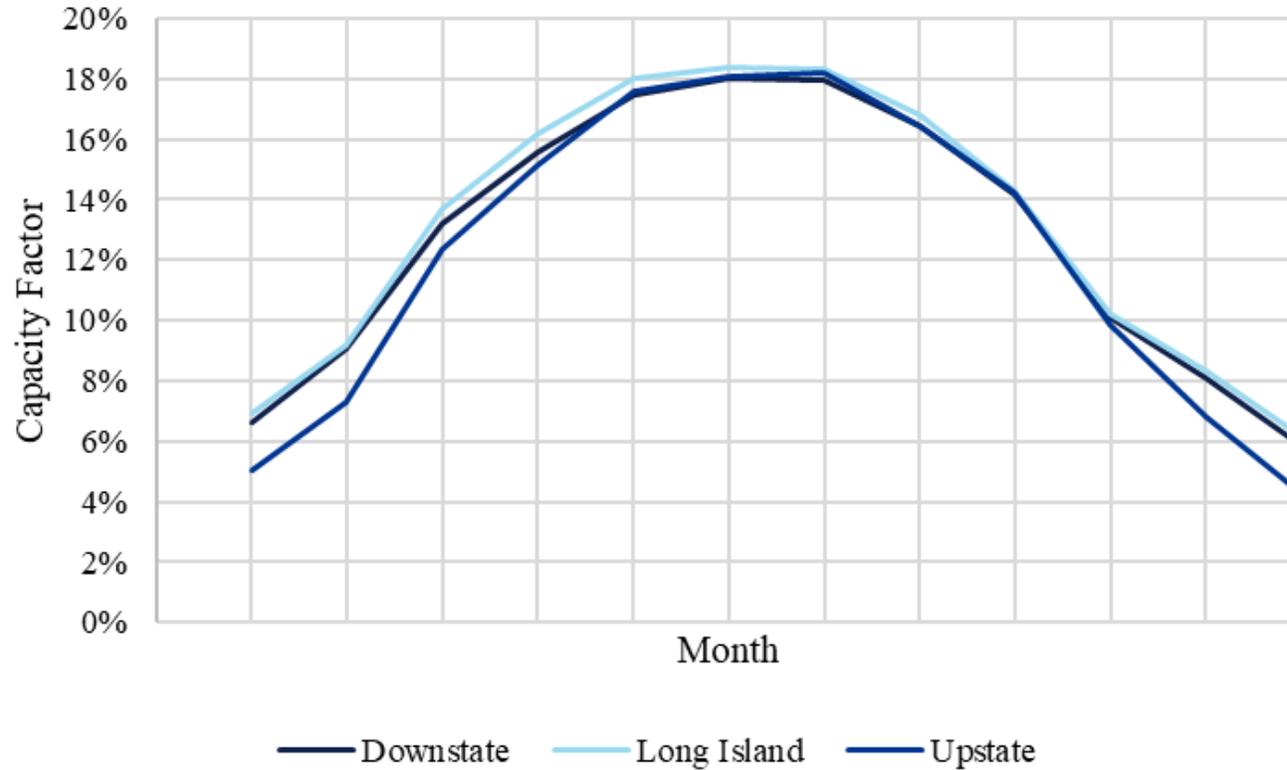
Monthly model with exponential decay tracks actual CF.

All regions