Centre for Energy and Environmental Markets

UNSW SYDNEY

Validation of SunSPOT Shading Methods and the impact on PV generation

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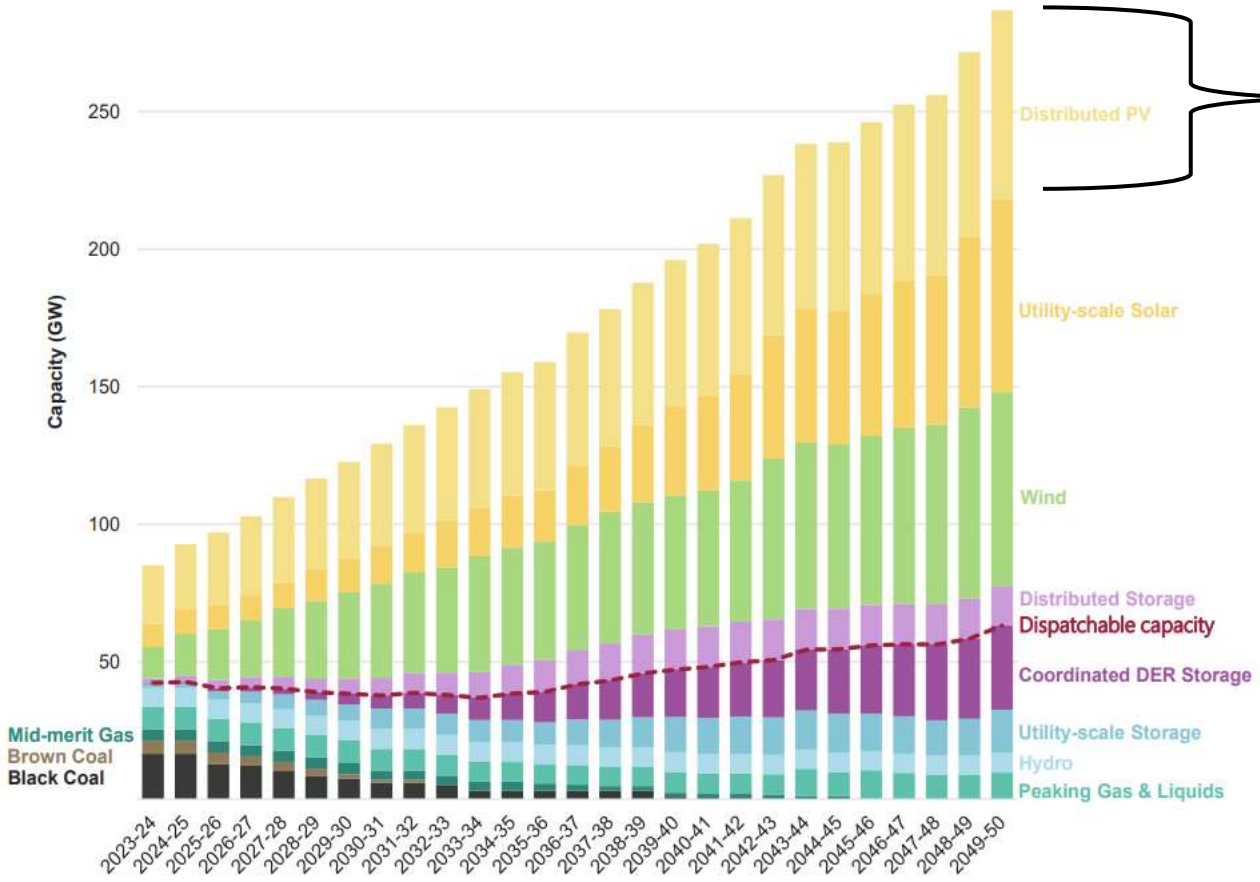
ISP Step Change – 69 GW of Rooftop PV by 2050

Figure 1 Forecast NEM capacity to 2050, *Step Change* scenario



69 GW, 20% of NEM Demand

Shaded Rooftop PV Systems

2016 Study (Haghdadi et al., 2016.) Analysed 5000 rooftop PV systems Australia wide.

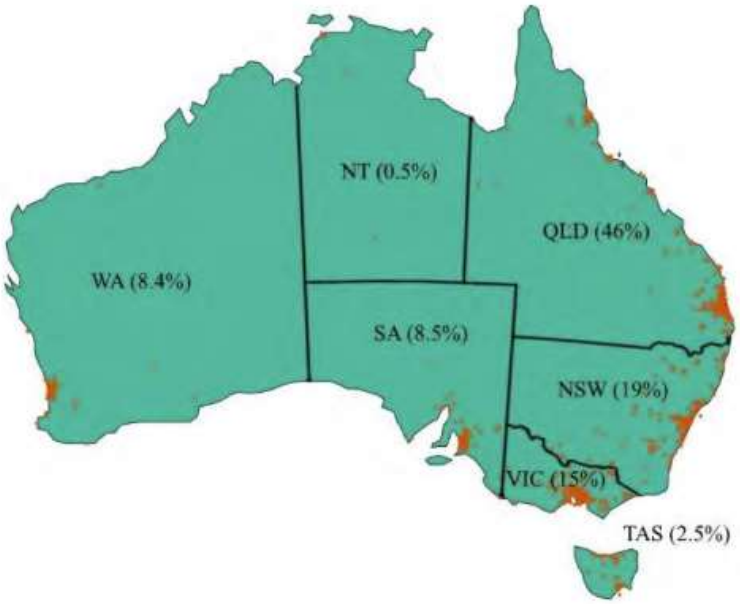


Figure 2 - Locations of Systems in PVOutput.org (Haghdadi et al., 2016.)

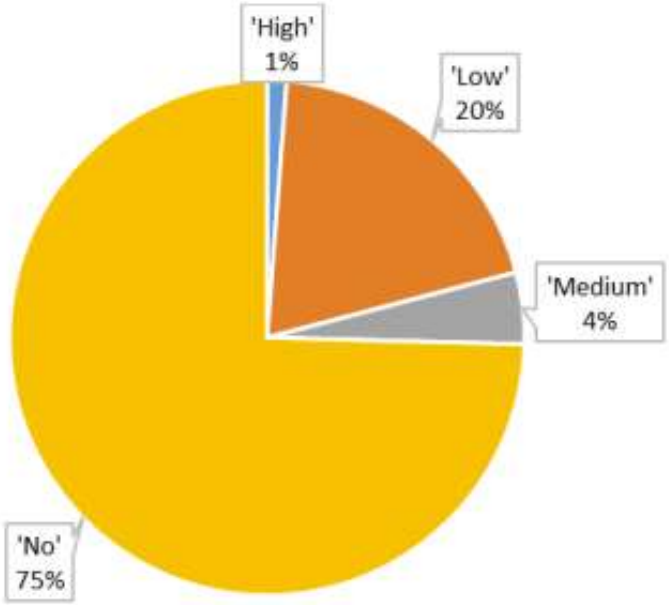
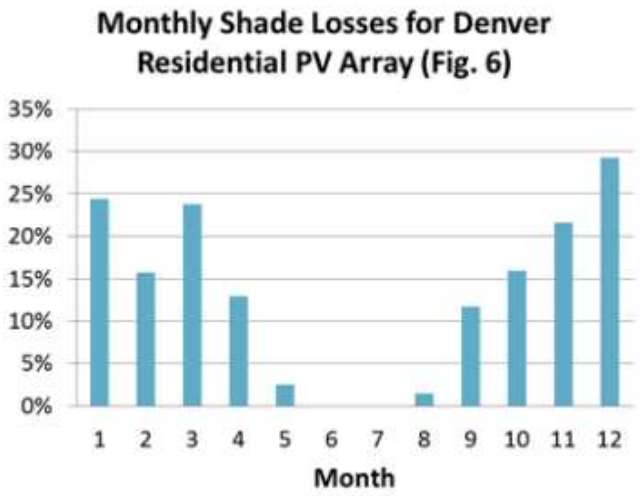


Figure 3 - Shading Status of Systems(Haghdadi et al., 2016.)

Impacts of Shading on residential PV Performance



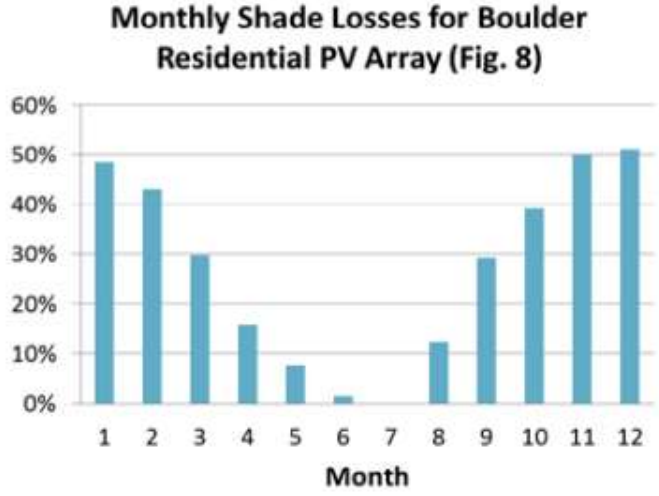
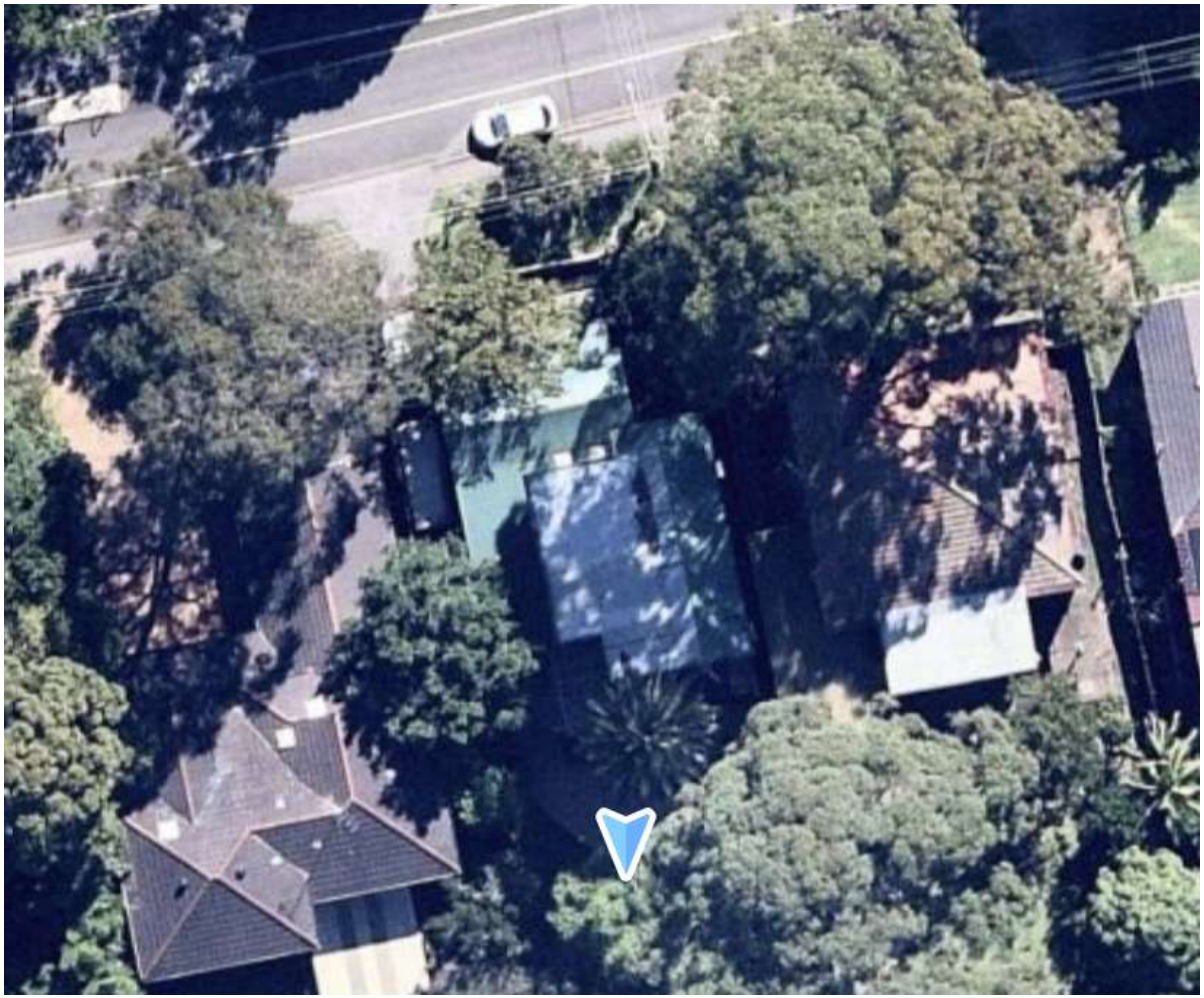


Figure 4 - Analysis of Shade losses for two sites in the USA (MacAlpine and Deline, 2015)

Shaded Roofs



Solar Energy Consumer Information Needs Research

Final report

"there was still a great deal of confusion and complexity consumers needed to navigate"…This included consumer needs to understand and assess their options including the impacts of shading on their proposed system and several other factors

sunspot.org.au

SunSPOT
Your Solar Savings Calculator

Find out how much solar could save you in 3 easy steps.

Your energy usage

Answer a few simple questions to find out how much electricity you use and receive your solar system suggestion.

Map your roof

Position solar panels on your roof and find out how much you will save.

Add a battery

Add a battery to compare system costs and savings.

Research Questions

1. **How well does the latest version of SunSPOT quantify the impacts of partial shading?**
2. **What is the accuracy of estimated PV Generation for partial shaded sites?**

Methodology

1. Locate Shaded Site with both Google 3D and LiDAR Data
2. Extract Dimensions of Shading Objects
3. Model System in SunSPOT – LiDAR and non-LiDAR Versions
4. Model System in SAM
5. Analyse Shading and Generation Results

SunSPOT
Your Solar Savings Calculator

NREL
NATIONAL RENEWABLE ENERGY LABORATORY

Modelled Systems

Figure 1 - Three modelled systems in SunSPOT non – LiDAR: System 1 (LHS), System 2 (Centre) & System 3 (RHS)

Limitations

- Despite high accuracy of Google 3D spatial data, without real world measurements it is difficult to accurately model shade objects in SAM and the non-LiDAR version of SunSPOT.
- Interpolation of SunSPOT shade data to match granularity of SAM data leads to errors – This mainly impacts the shade comparison.

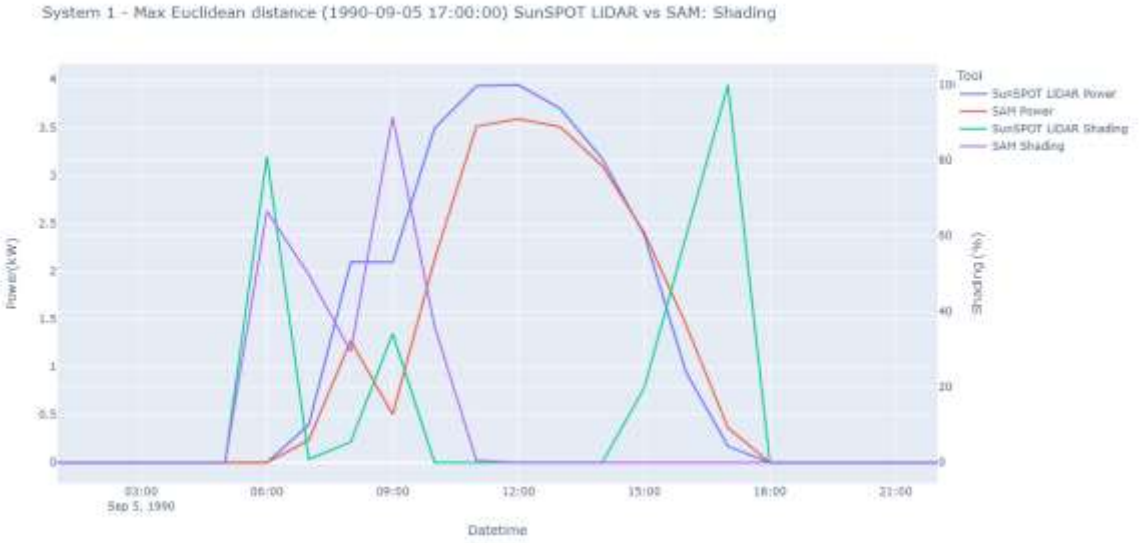
Shading(%) – Summary Statistics

System	Metric	SunSPOT LiDAR vs SunSPOT non - LiDAR	SunSPOT LiDAR vs SAM	SunSPOT non - LiDAR vs SAM
	Mean Bias Error (%)	3.238	0.135	-3.103
	Spearman Coefficient	0.575	0.616	0.784
1	Pearson Coefficient	0.647	0.736	0.782
	Mean Bias Error (%)	-2.435	-3.020	-0.585
	Spearman Coefficient	0.827	0.826	0.856
2	Pearson Coefficient	0.823	0.849	0.868
	Mean Bias Error (%)	-1.889	-7.674	-5.786
	Spearman Coefficient	0.761	0.812	0.771
3	Pearson Coefficient	0.887	0.807	0.835
	Mean Bias Error (%)	**-0.362**	**-3.520**	**-3.158**
	Spearman Coefficient	**0.721**	**0.751**	**0.804**
Average	**Pearson Coefficient**	**0.786**	**0.797**	**0.828**

Generation(kW) – Summary Statistics

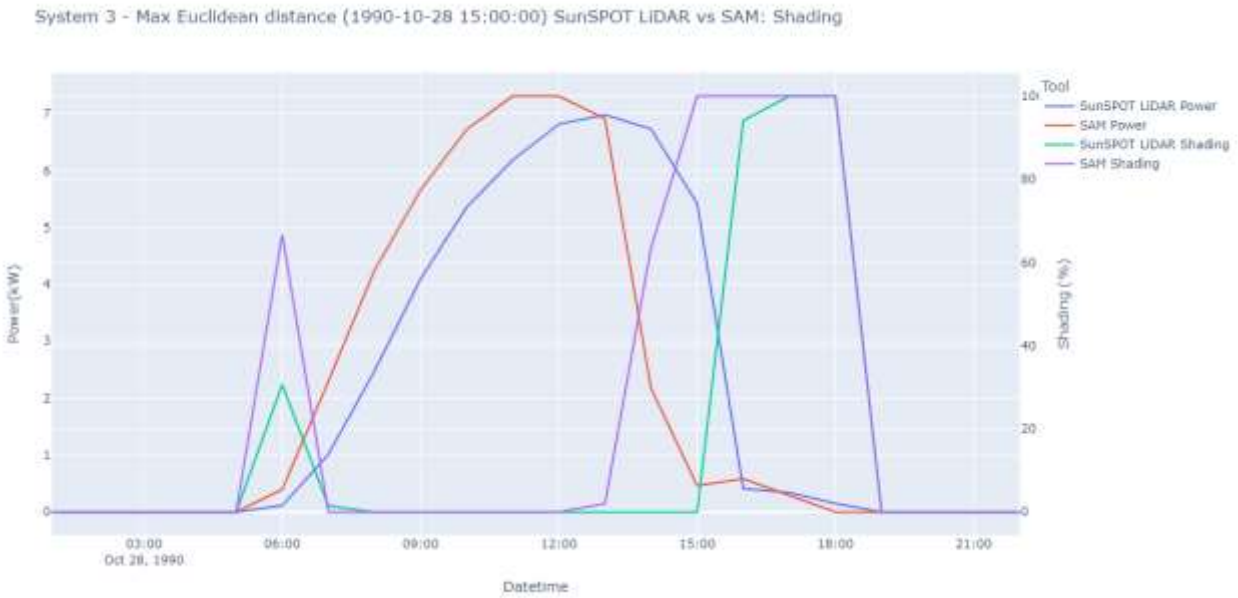
System	Metric	SunSPOT LiDAR vs SunSPOT non - LiDAR	SunSPOT LiDAR vs SAM	SunSPOT non - LiDAR vs SAM
	Mean Bias Error (kW)	-0.044	0.018	0.062
	Spearman Coefficient	0.992	0.974	0.977
1	Pearson Coefficient	0.959	0.862	0.887
	Mean Bias Error (kW)	0.025	0.112	0.086
	Spearman Coefficient	0.995	0.979	0.981
2	Pearson Coefficient	0.979	0.886	0.896
	Mean Bias Error (kW)	0.096	0.092	-0.003
	Spearman Coefficient	0.994	0.945	0.954
3	Pearson Coefficient	0.966	0.806	0.856
	Mean Bias Error (kW)	**0.025**	**0.074**	**0.049**
	Spearman Coefficient	**0.994**	**0.966**	**0.971**
Average	**Pearson Coefficient**	**0.968**	**0.851**	**0.880**

System 1:
Max Euclidean Distance Daily PV Profile

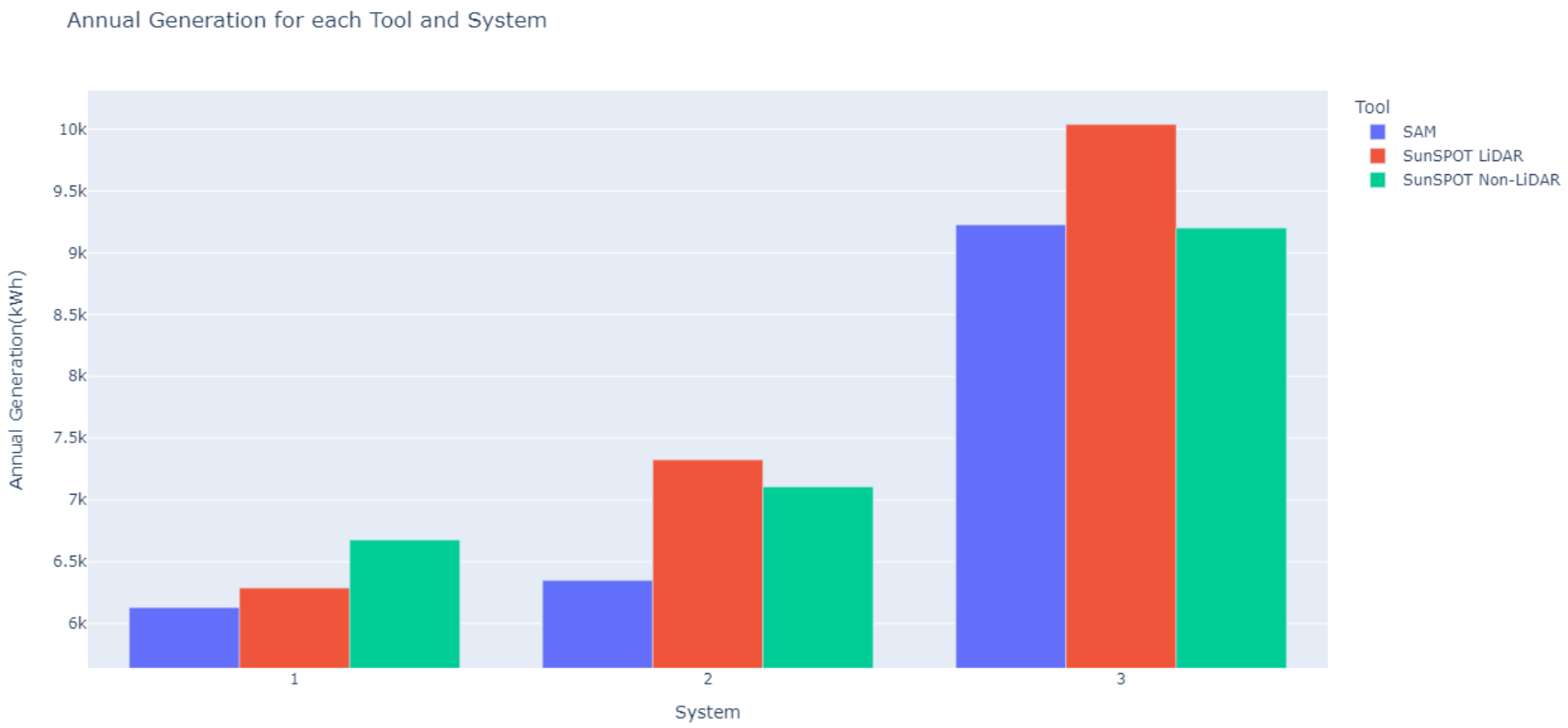


System 2:
Max Euclidean Distance
Daily PV Profile

System 3:
Max Euclidean Distance Daily PV Profile



Impact on Modelled Annual Generation



Summary

- Correlated Shading results between SAM and both SunSPOT methods.
- In instances of large discrepancies in shading values, high correlation of AC generation is present, indicating error in shading values potentially due to interpolation/granularity issues.
- Highly correlated AC Generation results between SAM and both SunSPOT methods.
- Similar Annual Generation Results between all three models. SunSPOT overestimates for all three sites. However, magnitude is small.
- SunSPOT is able to accurately estimate the AC performance of partial shaded PV systems in urban environments.

Future Work

- Analysis of larger number of sites with comparison to measured PV generation.
- Analysis on the impact on payback periods for a large sample of residential load profiles and tariffs.
- Research into end user ability to create accurate shading objects in non-LiDAR version of SunSPOT

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MacAlpine, S., Deline, C., 2015. Simplified method for modeling the impact of arbitrary partial shading conditions on PV array performance, in: 2015 IEEE 42nd Photovoltaic Specialist Conference (PVSC). Presented at the 2015 IEEE 42nd Photovoltaic Specialists Conference (PVSC), IEEE, New Orleans, LA, pp. 1–6. https://doi.org/10.1109/PVSC.2015.7355938

THANK YOU!