Soiling Losses of Utility-Scale PV Systems in Hot-Dry Desert Climates: Results from 4-16 Years Old Power Plants

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INTRODUCTION

- Soiling: Major O&M expense in the power plants
- Typical 3% annual de-rating factor used in energy estimation models may not be valid for all site conditions and configurations as they are influenced by: tilt angle, surrounding (urban or rural), installation type (fixed ground mount, fixed rooftop mount or 1-axis tracking) and the season (dry, windy, humid or rainy).
- The data presented in this study could be used to determine an appropriate de-rating factor in the energy estimation models and as a tool to determine if module cleaning is an economically viable option.

METHODOLOGY

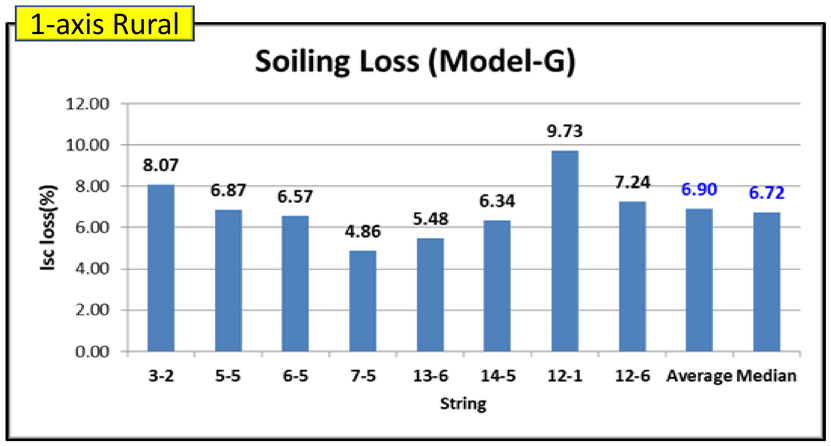
- I-V curves of soiled (existing operating state) string / module was individually measured.
- Water was used twice during the cleaning process (before and after using a mop)
- I-V curves were then taken after the string / module was completely dried without any trace of water or dirt.
- The curves were translated to STC and the percentage change between cleaned-string Isc and soiled-string Isc was then calculated.

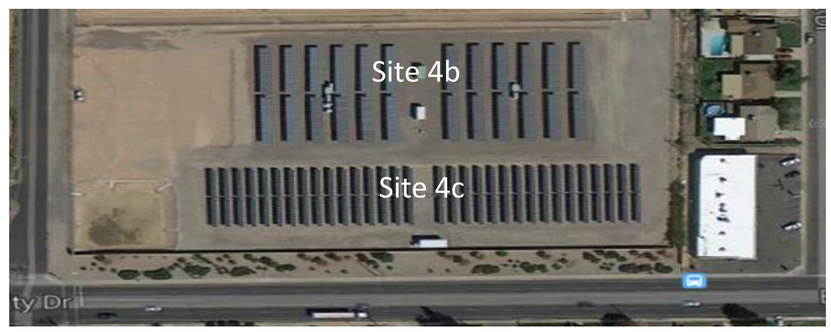
Plant site	Tilt / Orientation	Capacity (kW)	Surrou-nding	Field Age
Site 3 (Glendale)	1-axis tracking	243	Rural	12
Site 4b (Mesa)	Horizontal tilt (Ground)	113	Urban	16
Site 4c (Mesa)	1-axis tracking	250	Urban	4
Site 6 (Tempe)	Fixed 5° tilt (Rooftop)	97	Urban	8

RESULTS

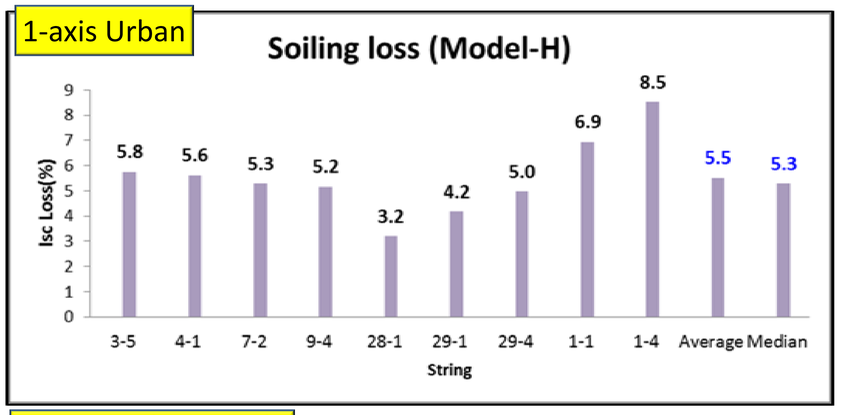
1-axis Rural

1-axis Rural

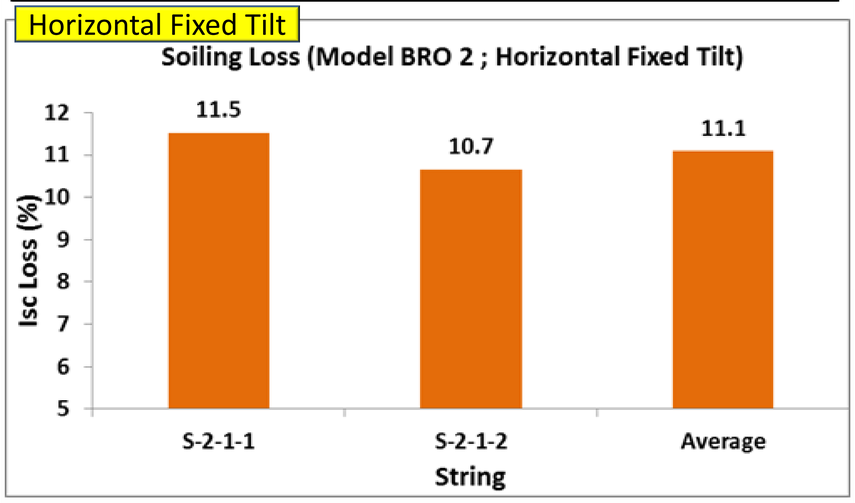




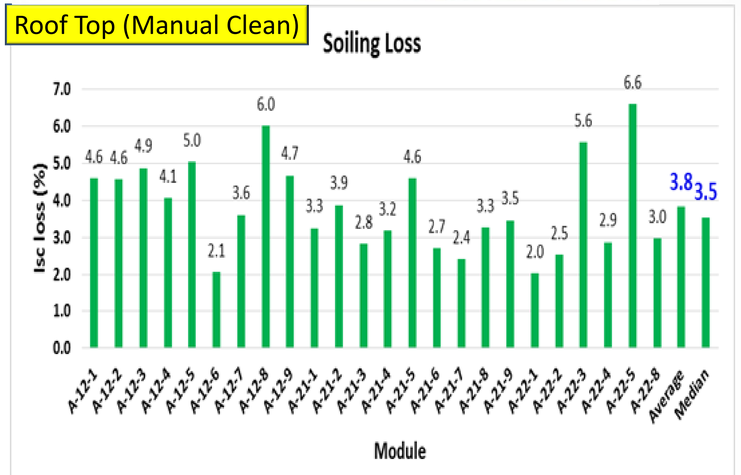
1-axis Urban



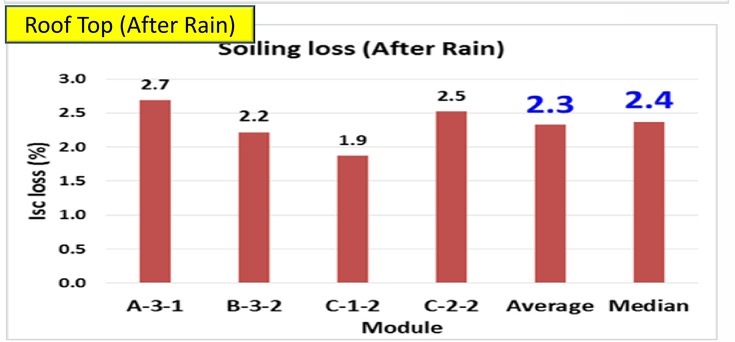
Horizontal Fixed Tilt



Roof Top (Manual Clean)



Roof Top (After Rain)



CONCLUSIONS

- The 1-axis tracker based modules in the rural surroundings have experienced a higher soiling loss (6.9%) as compared to the 1-axis tracker based modules in the urban surroundings (5.5% soiling loss).
- The horizontal tilt PV modules have experienced about two times (11% soiling loss) higher loss as compared to the 1-axis tracker based modules (5.5% soiling loss) for the same site (site 4).
- The rooftop mounted (even with near horizontal tilt) modules experience the lowest soiling loss (3.8%) as compared to the ground mounted modules.
- It appears that a few minutes of light rain (only about 0.04 inches) cleaning is only about 61% effective as compared to the manual cleaning for the (near) horizontal tilt modules.

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