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.

<table>
<thead>
<tr>
<th>Plant site</th>
<th>Tilt/ Orientation</th>
<th>Capacity (kW)</th>
<th>Surrounding</th>
<th>Field Age</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site 3 (Glendale)</td>
<td>1-axis tracking</td>
<td>243</td>
<td>Rural</td>
<td>12</td>
</tr>
<tr>
<td>Site 4b (Mesa)</td>
<td>Horizontal tilt</td>
<td>113</td>
<td>Urban</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>(Ground)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Site 4c (Mesa)</td>
<td>1-axis tracking</td>
<td>250</td>
<td>Urban</td>
<td>4</td>
</tr>
<tr>
<td>Site 6 (Tempe)</td>
<td>Fixed 5° tilt</td>
<td>97</td>
<td>Urban</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>(Rooftop)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

RESULTS

1-axis Rural

Soiling Loss (Model-G)

1-axis Urban

Soiling loss (Model-H)

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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