

SPATIAL SMOOTHING REDUCES PV CLIPPING!

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Why Spatial Smoothing Can Be Significant

- Classic modeling techniques assume that all inverters will operate at the same power at any time, with no variation in irradiance across a site (point-based clipping).
- Irradiance and clipping will vary across large PV systems.
- If inverter nameplate rating is greater than Point of Interconnection (POI) capacity, modeled clipping losses can be reduced.
- The Spatial Smoothing Factor (SSF) is a way to correct for point-based subhourly clipping techniques.

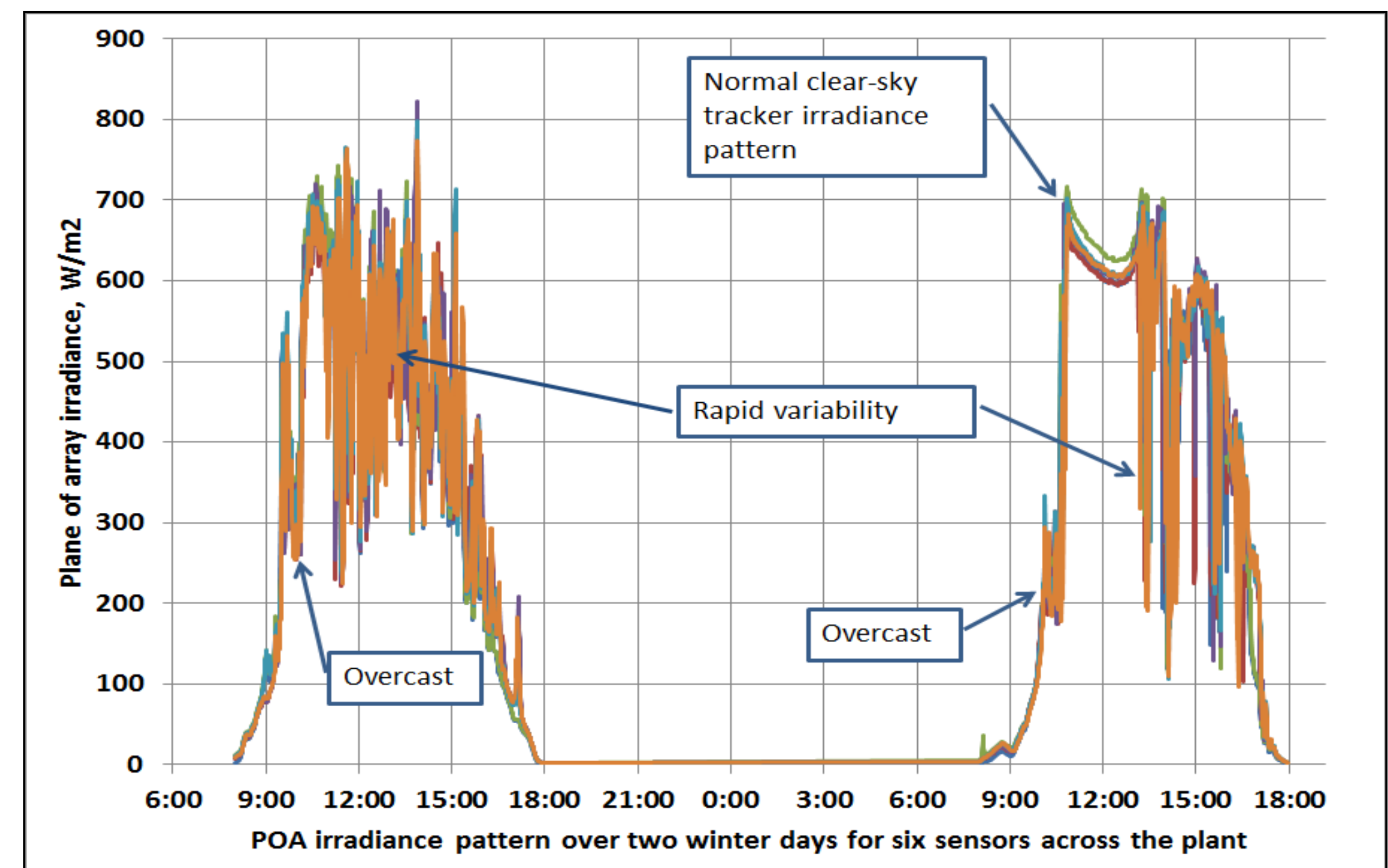


Figure 1: High variability irradiance indicates the potential for spatial smoothing of clipping loss

Study Approach

- A PV system in Texas consisting of 227 inverters with POI limit of 159 MWac spread over ~1,100 acres is selected for this study.
- The plant often reaches the POI limit, causing each 840 kW inverter to clip its output to as low as 700 kW. Under mixed skies, the plant controller can realize more power from sunnier inverters. This compensates for low output units, effectively reducing theoretical clipping losses from uniform inverter behavior.
- 1-min data is used to calculate clipping losses by comparing power and irradiance across the inverters spread over multiple concentric rings of increasing acreage, aka a spatial smoothing factor.

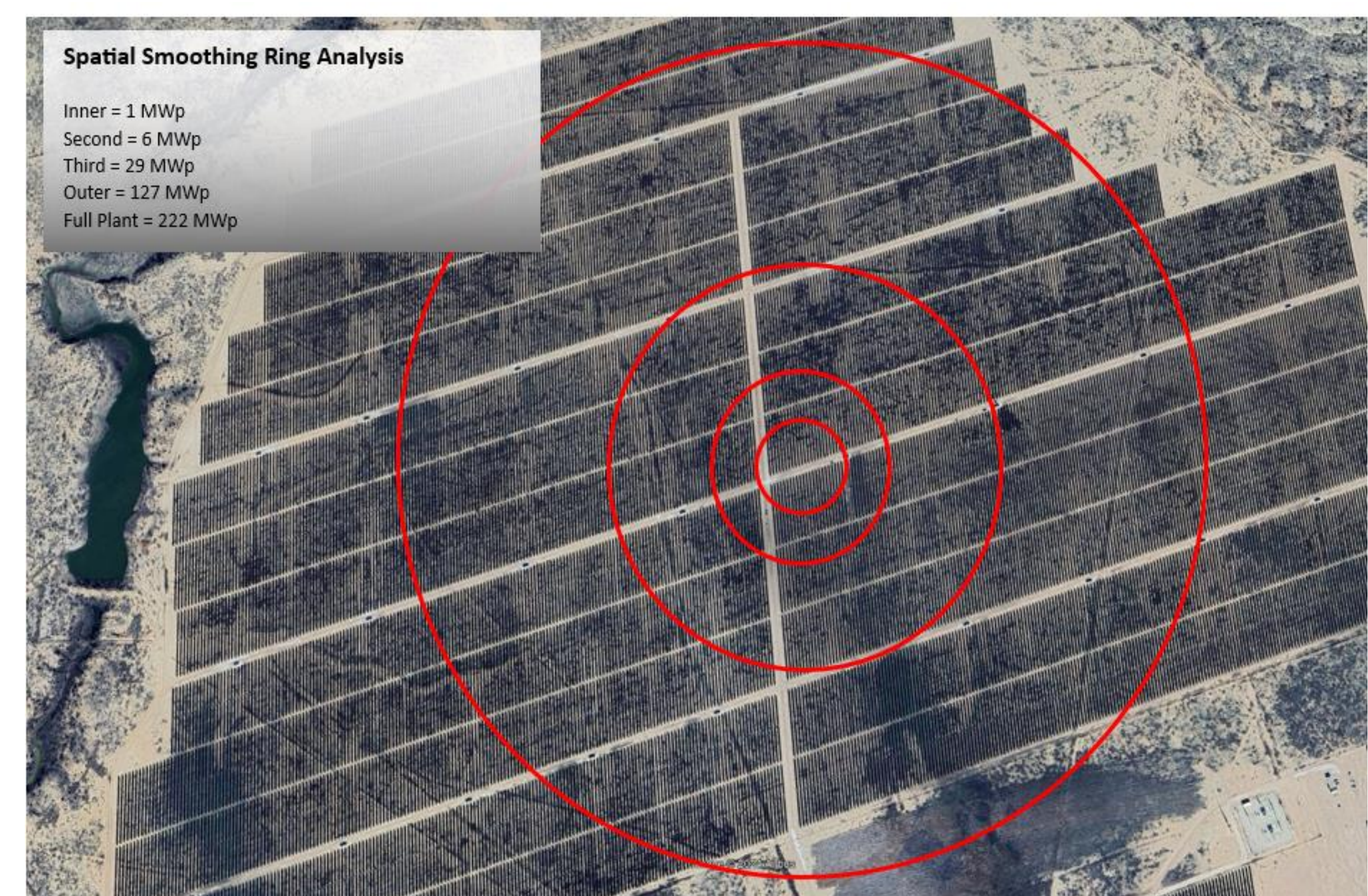


Figure 2: 1-min AC power data from a subset of inverters is used to calculate clipping reduction with an increase in plant acreage corresponding to concentric spatial rings, aka a spatial smoothing factor (SSF)

Results and Next Steps

- A generalized correlation was developed which quantifies the degree of spatial smoothing that can be achieved as a function of three terms: a plant's DC capacity, its POI/Inverter nameplate "cushion," and its annual point-based modeled clipping loss.
- Initial results show modeled subhourly clipping can be reduced by 15% as plant size increases to 1 GWp. For example, a 6% point-based clipping loss can be reduced to 5% with smoothing.
- The SSF improves at lower point-based clipping level.
- Our ongoing work includes expanding the study period to include more 2023 data. An updated correlation may result once the quality-control steps associated with this larger data set is complete.

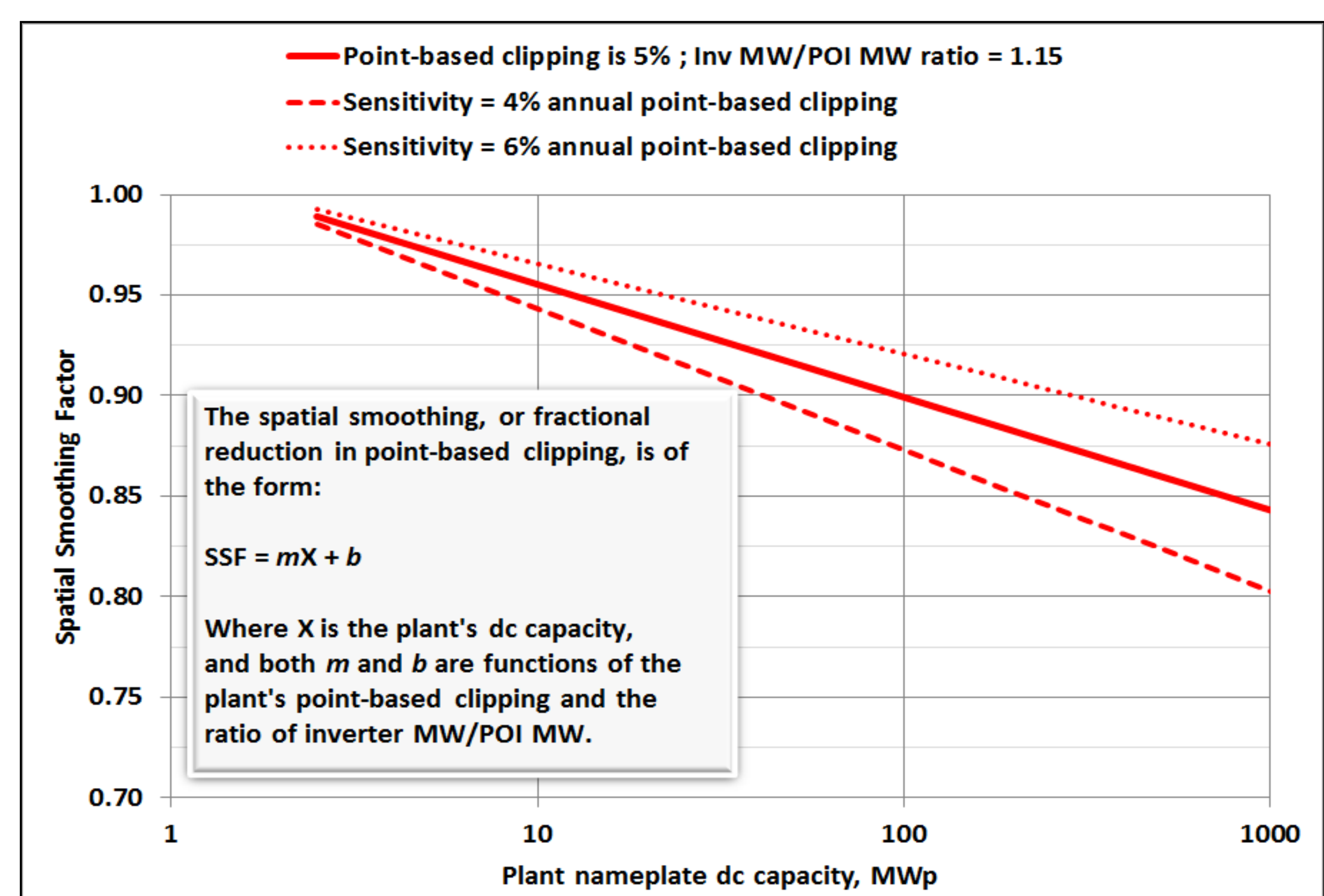


Figure 3: Generalized Spatial Smoothing Factor Equation as a function of plant's DC Capacity (MW) and POI/Inverter nameplate cushion