CESIR FLICKER SCREEN 6-MONTH TRIAL

Industry Response

3/27/2019

AGENDA

- Background
- Trial Objectives
- Results
- Additional Data
- Solutions
  - *Procedural*
  - *Methodological*
- Conclusions

BACKGROUND

- UTILITY FLICKER ANALYSIS CONCERNS BROUGHT TO ITWG BY INDUSTRY (I.E. IEEE 519 VS. IEEE 1453-2015)
- POST-CESIR TIME-SERIES ANALYSIS MUTUALLY ACCEPTED BY JU AND INDUSTRY
- MODIFICATION TO IEEE 1453 METHODOLOGY PROPOSED BY PTERRA FOR SUPPLEMENTAL SCREENING PROCESS
- JU AND INDUSTRY DISAGREEMENT ON UTILIZING ADAPTED SCREEN FOR CESIR PROCESS AS WELL
- ALL PARTIES MUTUALLY AGREE TO IMPLEMENT ADAPTED SCREEN TO SUPPLEMENTAL AND CESIR PROCESSES WITH SCREEN MODIFICATIONS TO BE CONSIDERED AFTER 6-MONTH TRIAL PERIOD

TRIAL OBJECTIVES

- HOW MANY PROJECTS FAILED THE ADAPTED FLICKER SCREEN?
- HOW MANY OF THESE PROJECTS PROCEEDED WITH/WITHOUT TIME-SERIES ANALYSIS?
- HOW MANY PROJECTS PASSED A TIME-SERIES ANALYSIS?
- HOW ARE UTILITIES IMPLEMENTING THIS ANALYSIS?
- IS THE SCREEN ADEQUATE IN IDENTIFYING PROJECTS WITH HIGH POTENTIAL FOR FLICKER ISSUES?
- ULTIMATELY, SHOULD THE CESIR SCREEN BE MODIFIED TO PREVENT TIME-INTENSIVE, EXPENSIVE, AND, IN MOST CASES, UNNECESSARY TIME-SERIES ANALYSES?

INDUSTRY REPRESENTATIVES DO NOT BELIEVE THAT THE DATA COLLECTED DURING THE TRIAL SUPPORT THE CONTINUED USE OF THE CURRENT UTILITY PRACTICES

RESULTS

Data Gathered by the Industry

- PROJECTS COLLECTED: **34**
  - Avangrid: 9
  - CHG&E: 5
  - ConEd: 3
  - National Grid: 12
  - Orange & Rockland: 1
- PROJECTS THAT FAILED SCREEN: **20**/34
  - Avangrid: 7
  - CHG&E: 5
  - ConEd: 0
  - National Grid: 7
  - Orange & Rockland: 1
- PROJECTS PROCEEDED BY TIME-SERIES: **9**/30
  - Avangrid: 1
  - CHG&E: 2
  - ConEd: 0
  - National Grid: 5
  - Orange & Rockland: 1
- PROJECTS THAT PASSED TIME-SERIES: **9**/30
  - Avangrid: In Progress
  - CHG&E: 2
  - ConEd: 0
  - National Grid: 5
  - Orange & Rockland: 1

RESULTS

Data Gathered by the Industry - Example Project Specifics

- PROJECT 1 - 5,000KW DOWNSIZED TO 3,250KW: **Time-Series Passed**
  - Pst found with Screen: 0.52 (project contribution)
  - Pst found with Time-Series without Geo-Smoothing: 0.18 (project contribution)
- PROJECT 2 - 4,000KW DOWNSIZED TO 500KW: **Time-Series Passed**
  - Pst found with Screen: >0.39 (project contribution)
  - Pst found with Time-Series without Geo-Smoothing: 1.07 (circuit maximum)
  - Pst found with Time-Series with Geo-Smoothing: 0.38 (circuit maximum)
- PROJECT 3 - 5,000KW DOWNSIZED TO 3,250KW: **Time-Series Passed**
  - Pst found with Screen: 0.39145
  - Pst found with Time-Series with Geo-Smoothing: 0.014

RESULTS

Procedural: How are Utilities Implementing Screen and Time-Series Analyses?

- CESIR/SUPPLEMENTAL FLICKER SCREEN:
  - Projects which fail screen in Supplemental often times do not have the funds to proceed with full CESIR study.
  - One utility has been known to reduce customer system size of a project in CESIR without informing the developer and performing subsequent analysis on only the reduced system.
  - *"At least one service territory appears to be studying flicker under the current methodology not just for the individual system but for 'the aggregate generation within 0.75 miles of the IPP'"* - Dr. Brice Smith

- POST-CESIR TIME-SERIES ANALYSIS:
  - Cost and timeline of time-series analysis varies widely between utilities
    - Cost: $0 to $20,000
    - Timeline: 7 days to several months
  - Projects that fail only the flicker screen in the Supplemental cannot typically afford a full CESIR study or additional Time-Series Analysis
  - No consistent usage of geographic smoothing in final analysis

RESULTS

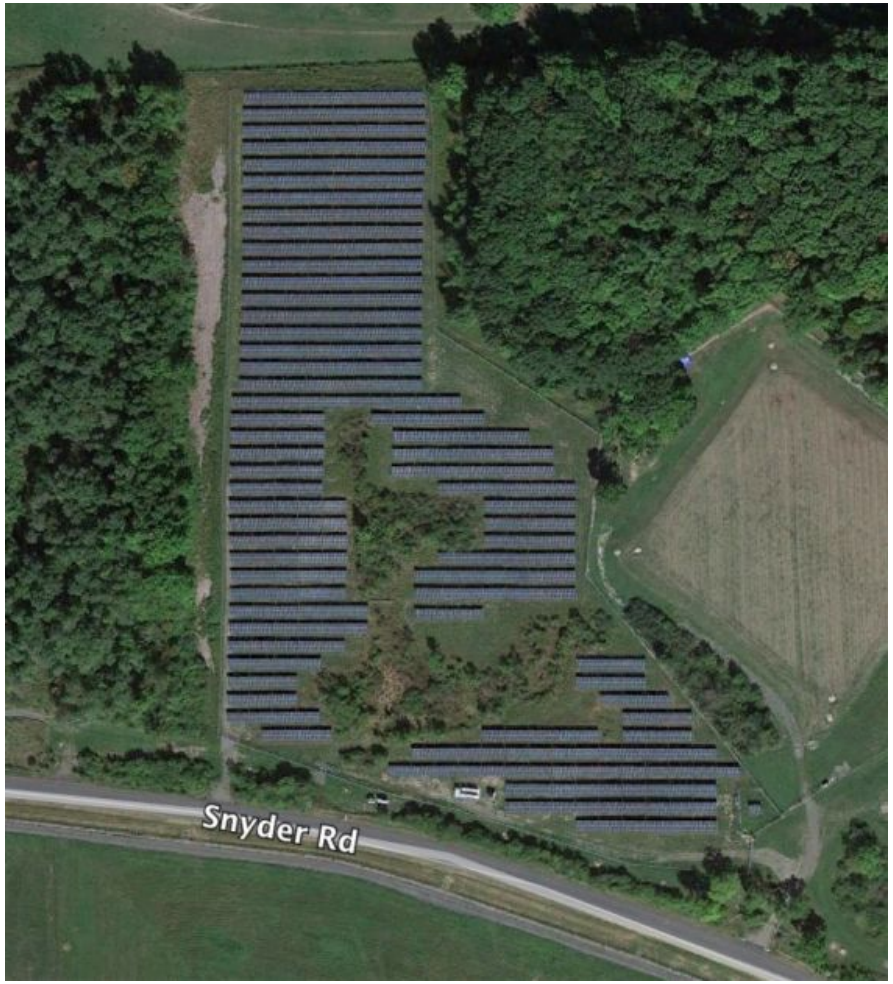
Methodological: What does the data tell us about the screen?

- 60% OF PROJECTS THAT WENT THROUGH CESIR PROCESS FAILED THE FLICKER SCREEN
- ALL TIME-SERIES STUDIES PERFORMED WERE PASSED BY SIGNIFICANT MARGINS EVEN IN CASES WHEN GEOGRAPHIC SMOOTHING WAS NOT APPLIED
- SCREEN IS CLEARLY MORE CONSERVATIVE THAN WE HAD ORIGINALLY THOUGHT
  - "*Despite the goal of improving and modernizing the flicker standards through these changes, in a study of seven CESIR reports completed by National Grid prior to the current change in methodology, we found that six of the seven 2MW facilities (or more than 85%) that passed the previous flicker screening would now likely have failed under the current use of the short-circuit current approximation in the shape factor methodology*" - Dr. Brice Smith
- SCREEN DOES NOT EFFECTIVELY EVALUATE THE RISK OF FLICKER CAUSED BY PV

Additional Data:

Built in Conservativeness of the Shape Factor Method

- EVEN WITH THE USE OF ($\Delta V/V$), ELEMENTS OF EXTREME CONSERVATIVENESS IN THE SHAPE FACTOR APPROACH REMAIN DUE TO 0% TO 100% TRANSITION IN 1 SECOND:
  - Example: Implied Cloud Speed for 2 MW Cornell Facility in CNY
    - Minimum cloud width to completely cover facility is 200m, therefore, this implies a cloud speed of 200 m/s (447 mph) to go from 0% to 100% in one second. Then this phenomenon must repeat.
    - Note: Fastest ever recorded wind gust, a direct correlation with cloud speed, was 253 mph (World Meteorological Association, Feb 2017)



Additional Data:

Geographic Dispersion Reduces Fluctuations at MW Scale Facilities:

- VOLTAGE FLUCTUATIONS AT 500 KW SITE ANALYZED:
  - "Even during a highly variable day, all 1-second step changes were well below 10% of the system's rated capacity and less than 1% of the step changes were larger than 5% of the nameplate capacity."

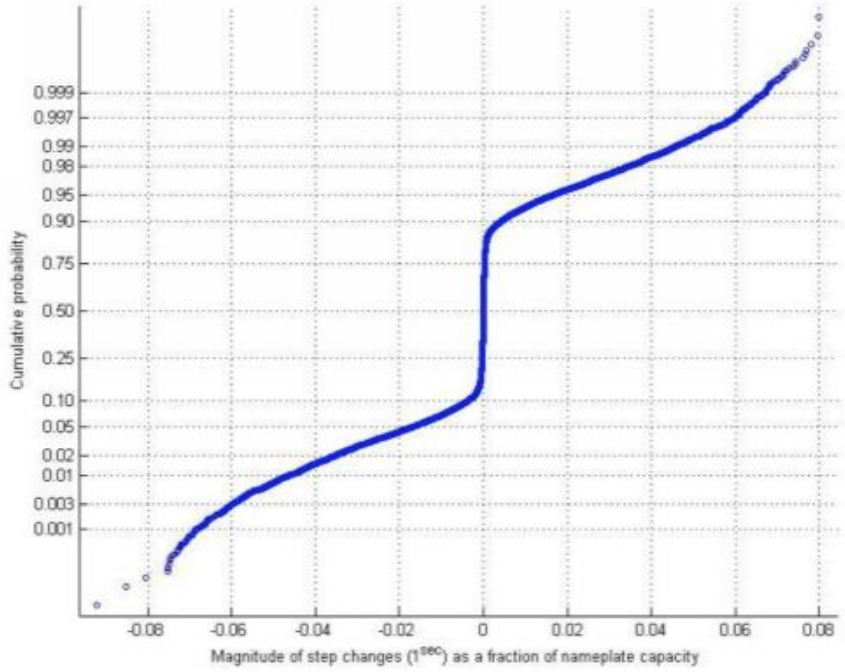
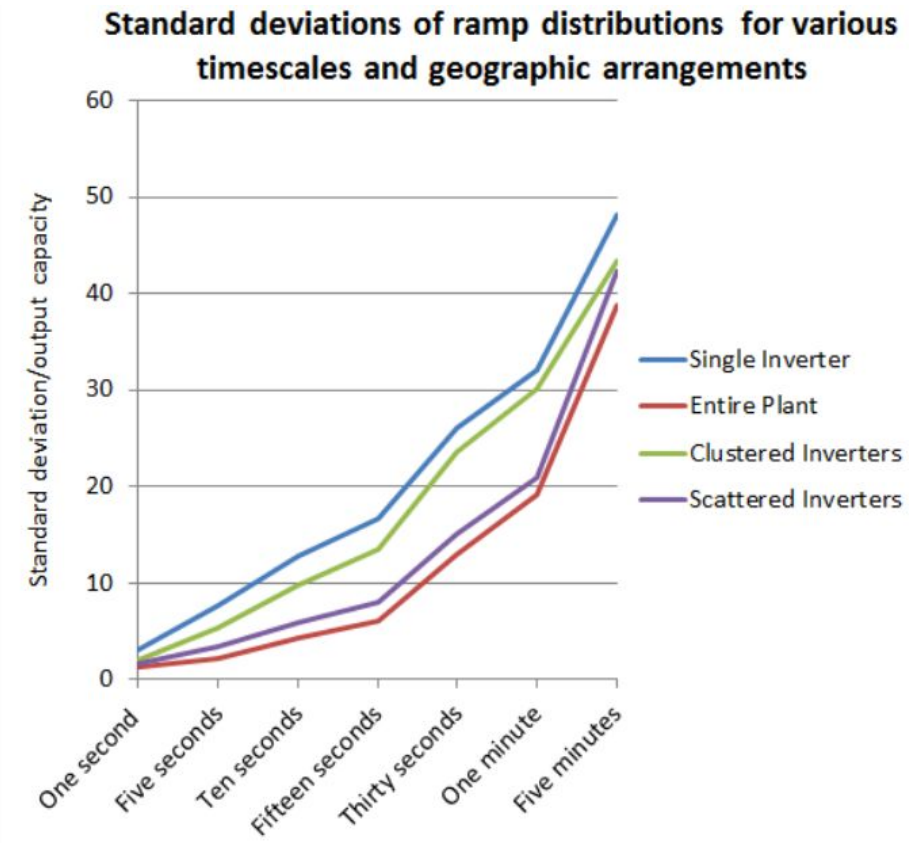


Figure 3a: Cumulative distribution function of 1-second

From: *PV Power Ramp Rates, Sampling Frequency and Effect on Grid Voltage*, Presented at European Photovoltaic Solar Energy Conference, Sept 2013

Additional Data:

Geographic Smoothing of Power Ramp Rates:



- FOR REAL SYSTEMS, THE GEOGRAPHIC SMOOTHING OVER MW SCALE ARRAYS REDUCE THE ACTUAL FLUCTUATIONS IN OUTPUT SUBSTANTIVELY
- GEOGRAPHIC SMOOTHING BETWEEN DIFFERENT ARRAYS WILL BE EVEN MORE DRAMATIC ARGUING STRONGLY AGAINST THE 100% TO 0% TRANSITION FOR ALL PV WITHIN A 0.75 or .25 MILE RADIUS AS IS BEING DONE BY SOME NEW YORK UTILITIES.

From: Shedd, S., Hodge, B., Florita, A., Orwig, K., 2012. *A Statistical Characterization of Solar Photovoltaic Power Variability at Small Timescales*. 2nd Annual International Workshop on Integration of Solar Power into Power Systems Conference, Lisbon, Portugal.

Additional Data:

99th Percentile Fluctuations in NREL Single Point Irradiance Data:

Data Source	Resolution	99th Percentile Fluctuation (8am to 8pm)
Oak Ridge (nine years of data)	1 minute	38%
Elizabeth City State University (six years of data)	5 minute	43%
Bluefield College (seven years of data)	5 minute	43%

SOLUTIONS

Recommended Procedural Modifications to Flicker Screen Usage

- REVISED CESIR SCREEN (PROPOSED) OR TIME-SERIES OPTION POST-SUPPLEMENTAL REVIEW
  - Established procedures and easily available data sets should reduce both cost and timeline of a time-series analysis
  - Projects which fail only Screen H of the Supplemental Review should be able to proceed with a Revised CESIR Flicker Screen (proposed) or, if needed, a Time-Series without being subject to a full CESIR
- PRE-CESIR OPT-IN OPTION TO PERFORM PARALLEL TIME-SERIES ANALYSIS
  - Developers should be able to opt into a time-series analysis to be performed in parallel with the CESIR to reduce cost and timeline
- STANDARDIZED USAGE OF GEOGRAPHIC SMOOTHING FOR TIME-SERIES STUDIES
  - Trial and external data suggest that geographic smoothing has major impacts on a site's flicker impact and should be analyzed as such
- TRANSPARENCY THROUGHOUT THE CESIR PROCESS REGARDING INTX ISSUES AND MITIGATIONS
  - Utilities should not be able to apply mitigation efforts such as downsizing prior to agreement by the developer for the change
- FLICKER SHOULD BE ANALYZED ON AN INDIVIDUAL PROJECT'S CONTRIBUTION, NOT AGGREGATE

SOLUTIONS

Proposed Methodological Modifications to Flicker Screen

- UTILIZE ACTUAL (ΔV/V) FROM A POWER FLOW MODEL IN CESIR LEVEL FLICKER SCREEN
  - Consistent with IEEE 1453-2015 (Section 7.1 - Use of Shape Factors)
- CALCULATION:
  - Pst = (ΔV/V) x (0.2/2.568%)
  - (ΔV/V) = (0.35) * 0.02568/0.2 = **4.49%**
- THE SIZE OF **4.49%** LIMIT FOR FLICKER IS SIMPLY THE MATHEMATICAL STATEMENT THAT VISIBLE FLICKER IS NOT LIKELY TO EVER BE A CONCERN FOR SOLAR PV AS FACILITIES WILL LIKELY RUN INTO OTHER LIMITS (SUCH AS ANSI C84.1) FIRST

7.1 Use of shape factors

The flicker severity can be computed using the following equation:

$$P_{ST} = \left(\frac{d}{d_{Pst=1}} \right) \times F \qquad (14)$$

where

F is a shape factor (see Annex C). For motor-starting without inrush mitigation, a value of unity may be used for F.

Relative voltage change (d) can be evaluated as the ratio of load power change (ΔS_i) to the short-circuit power (S_{SC}). The following equation may be used for balanced three-phase loads:

$$d = \frac{\Delta V}{V_r} \approx \frac{\Delta S_i}{S_{SC}} \qquad (15)$$

- IMPORTANT TO NOTE THAT WHILE **4.49%** SCREENING LEVEL IS NEAR ANSI C84.1 VOLTAGE LIMITS, THE ANSI LIMITS WILL REMAIN IN EFFECT AND SO NO DEVIATIONS OVER THE STANDARD 114 TO 126 V RANGE WILL BE ALLOWED REGARDLESS OF FLICKER RESULTS.

CONCLUSIONS

- ITWG MUST RECONSIDER APPLICATION OF THE SCREEN
  - At minimum using actual Voltage Fluctuation values
  - Evaluate Pst limit of 0.35 - IEEE stated minimum
  - Thorough evaluation from the Joint Utilities
- AIM FOR CONSISTENCY IN ANALYSIS AND PROCESS
  - Review for inconsistencies between different Engineering Firms performing Time Series
    - Use of Geographic Smoothing
    - 1 Sec. Irradiance / Power output data source

SOURCES

- "SOLAR INDUSTRY CONCERNS ON THE IMPLEMENTATION OF IEEE 1453 SCREENING DURING CESIR STUDY", DR. BRICE SMITH, NYSEIA (OCTOBER 24, 2018)