Quasi-Static Time-Series Photovoltaic Hosting Capacity Methodology and Metrics

Akshay Kumar Jain, Kelsey Horowitz, Fei Ding, Nicolas Gensollen, Barry Mather, Bryan Palminter

Snapshot PV Hosting Capacity

- “Snapshot” or “static” hosting capacity study is the method for determining the amount of PV that a feeder can host without adverse grid impacts that might require changes or upgrades to the distribution system.

- The analysis is historically conducted at worst-case time points.

- The first parameter violated determines the hosting capacity and is often the upper voltage limit as per ANSI standard C84.1-2016, Range A.

- However, this ANSI standard also allows infringing violations of the voltage limit as long as they are corrected.

- Operation of voltage control devices which can regulate voltages cannot be captured faithfully using this study methodology.

- Similarly, behavior of some advanced control algorithms which could be used to expand the hosting capacity cannot be captured.

QSTS PV Hosting Capacity Challenges

- To get the most accurate PV hosting capacity results, the QSTS simulations should be conducted at a time resolution that can adequately capture the time delays of the voltage control devices.

- Computational and data challenges have limited the efforts to use long (e.g., hourly) timesteps.

- Longer time steps may not accurately capture cloud-induced generation variability or corresponding regulator and capacitor control responses.

- A new set of metrics will have to be defined that conform more closely with the established ANSI standards and can allow infringing parameter violations.

QSTS PV Hosting Capacity Metrics

The objective of this paper was to explore potential metrics for determining QSTS PV hosting capacity, however the threshold for monitoring these metrics will be determined by the comfort level of utilities in allowing voltage deviations or thermal violations on their system for small periods of time

Loading Metrics:

- Moving n-hour average loading: A n-hour moving average of each transformer’s and line’s loading as a percentage of its rated capacity is calculated.

- Instantaneous over-loading: The instantaneous loading of the transformers and lines should not exceed pre-determined threshold values.

Monte Carlo simulation was used to generate PV deployment scenarios covering 5% to 100% of the customers on the feeder, in a 5% step size.

The test was repeated 10 times for each of these percentage penetration levels.

200 scenarios were analyzed at the peak and minimum loading time points.

The PV hosting capacity limit was reached for deployment 8 at 65 percent PV penetration.

QSTS Results:

- All the penetration levels for deployment 8 were analyzed using a year-long QSTS PV hosting capacity study with 1-minute resolution load and PV profiles.

- Our QSTS results suggest that snapshot hosting capacity may be conservative in some scenarios compared to violations allowable under the ANSI standard.

- In this case, our QSTS dynamic hosting capacity was 35% higher than the snapshot analysis.

References


