PV HOSTING CAPACITY STUDY

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An *Introduction* to PV Hosting Capacity concepts and definitions

- PV Hosting Capacity Study – discussion of a distribution study approach with a
  - description of *methodology* used
  - discussion of study *analysis* and *results*
PV HOSTING CAPACITY - Introduction

- **PV** - Photovoltaic or solar

- **PV Hosting Capacity** - maximum PV generation that can be added to the distribution feeder with the existing system configuration and infrastructure. The Hosting Capacity is the point where a problem may arise.

- Depends on many factors and can change with feeder configuration changes – analysis and results are generalized and not tied to specific installations.
PV HOSTING CAPACITY - Background

Why is this of interest or concern?

- Solar installations are increasing in Texas (residential, commercial, and utility scale)
- Most small solar installations are added without evaluation of the distribution system.
- Utilities have increased concern over the impact of higher penetration levels of both small scale solar installations and new large scale installations
- Information can be used in rate tables and utility policy.

Goal of PV Hosting Capacity – provide insight to the utility on the amount of PV generation that could be added without adverse impacts
STUDY CONSIDERATIONS AND APPROACH

- Each feeder has a PV hosting capacity and the hosting capacity will be established independently.

- Study focuses on individual distribution feeders' capacity. Although reverse power flow may occur with generation at the hosting capacity level, the study does not evaluate impact of reverse power flow at the substation level.

- A PV hosting capacity will be calculated for each feeder for “Large Scale” solar and “Small Scale” solar.
**STUDY METHODOLOGY**

Large-scale analysis - with one large solar generation site at the end of each radial feeder.

Small-scale analysis - system-wide small solar generation sites distributed along each radial feeder.
Large-scale analysis - with one large solar generation site

- Location of the large-scale PV injection site plays a significant role in determining PV hosting capacity.
- Generally located at the end of the main three-phase distribution line (furthest from the substation source).
- Feasibility of injection site location was not evaluated.
- Some feeders analysis include evaluation of more than one location.
**STUDY METHODOLOGY**

Small-scale analysis - system-wide small solar generation sites

- Generation sites of **equal size** were added to the system models
- Distributed along each radial feeder at locations of existing meters
- Considerations were made for modeling PV generation sites at multi-meter housing location

`Large Scale and Small Scale PV Hosting Capacities were evaluated and determined independently.`
A utility is responsible to all customers on a distribution circuit and must ensure the addition of any load or generation not result in power quality or reliability issues for adjacent customers. Study Limiting Criteria is established.

- **Conductor Loading** – conductor loading level of 60% of Maximum Ratings
- **Voltage Limitations** – limit +/- 5% voltage levels
  (High voltage 126 V on 120 volt base)
- **Voltage Fluctuations** – limit of 3-5% to reduce the impact of voltage variations introduced by the intermittency of PV generation
A base case model must be established representing a normal system configuration for use in the study.

- Remove any backfeeding configuration
- Make modelling exclusions based on accuracy and availability of system data, such as disregarding secondary conductor.

Generators are added to distribution system model on every feeder assuming unity power factor. Models are prepared for “Large Scale” and “Small Scale” studies.
It’s unlikely that the system data or software is available to perform time series simulations to determine the effect of PV generation on the electric distribution system at all times.

- **Multiple** system models are developed to represent the worst case conditions or most limiting conditions on the system for hosting PV generation.

- How do you determine the system status or conditions that would represent the most limiting condition on a feeder? What are the contributing factors and considerations?
ANALYSIS - Modeling

Look at the feeder data and consider the limiting criteria ...

Conductor Loading  Voltage Levels  Voltage Fluctuations

(Sunny Day)                      (Cloudy Day)             (Mid-afternoon Clouds)

minimum Demand?
Summer Peak?
Winter Peak?

Determine the times where the distribution system will be most affected by the PV generation and most likely to violate the set study criteria
**ANALYSIS**

**System models** are developed for:
- Summer Peak kW demand
- Fall *off-peak* demand
- Spring *off-peak* demand

**Collect & Evaluate the System Data**
- 12 months of 15-min interval demand data is evaluated for each feeder
- For evaluation of **solar** generation, the evaluation must be limited to daylight (generation) hours
- Conservative estimate is to limit evaluation between sunrise and sunset times
Example – look at voltage conditions along the feeder, in a **lightly loaded conditions**.
The most common limiting criteria are high voltage and conductor loading, but voltage fluctuations was also a limiting criteria in calculating hosting capacity.

The PV hosting capacity was very limited on feeders with long feeder lengths.

- In both small scale and large scale analysis

The highest PV hosting capacity for small-scale and large scale calculations was on short feeders with majority of the main backbone large conductor (3Ø, 795 conductor).

The PV hosting capacity on feeders with generation already present was limited.
GENERAL RESULTS & CONCLUSIONS

- Generally, the evaluation showed the **large-scale PV hosting capacity** was *more limited* than the small-scale hosting capacity *on the same feeder*.

- As a **rule of thumb**, without analysis completed, some utilities use **15% PV penetration limit**.
  - % is defined as the PV generation/ peak demand
  - This can overestimate or underestimate the actual hosting capacity. (For example: 9% to 200%)

- Given a calculated **small scale PV hosting capacity** it is of interest to know what % of existing homes that represents. *How many customers have to install solar panels before we see a problem?* (Ranged from 15% to 230%. Based on 7 kW solar installation size.)
Takeaway...

- The analysis results are based on the current feeder configuration.
- The results are generalized but gives the utility insight into how sensitive the system is to increases PV installations. May assist in establishing PV policy and rates.
- Specialized studies should be completed for individual installations.
QUESTIONS ?
THANK YOU