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Distribution Grid Hosting Capacity for Distributed Solar and EV Charging

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EXECUTIVE SUMMARY

Applying time-series hosting capacity analysis to a representative sample of distribution feeders, we find that voltage constraints, not thermal constraints, are the binding limit on distributed solar hosting capacity for the large majority of feeders analyzed, while EV charging hosting capacity is more evenly split between voltage and thermal limits depending on charging load coincidence with existing feeder demand.

Abstract

This study applies quasi-static time-series hosting capacity analysis to a representative sample of distribution feeders to evaluate the binding technical constraint, voltage or thermal, limiting additional distributed solar and electric vehicle charging capacity. We find voltage rise is the dominant binding constraint for distributed solar across the large majority of feeders analyzed, while EV charging hosting capacity shows a more even split between voltage and thermal constraints, driven primarily by whether charging load coincides temporally with existing peak feeder demand.

Introduction

Distribution utilities increasingly rely on hosting capacity analysis to provide developers and customers with feeder-specific guidance on available capacity for new distributed solar and EV charging interconnections, replacing more conservative generic screening thresholds. Understanding which technical constraint, voltage or thermal, most often binds for each resource type has direct implications for which mitigation measures, voltage regulation equipment versus feeder or transformer upgrades, deliver the most hosting capacity per dollar invested.

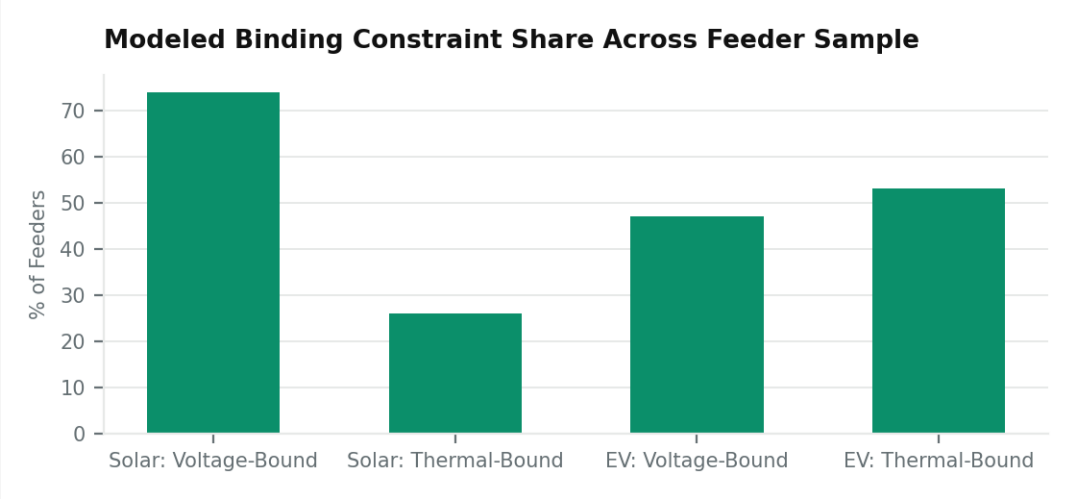
Methodology

We applied quasi-static time-series hosting capacity analysis, simulating power flow across a full year of representative load and generation profiles at high time resolution, to a sample of distribution feeders selected to represent a range of feeder lengths, existing DER penetration, and voltage regulation equipment configurations. For each feeder, we incrementally added modeled distributed solar and, separately, EV charging load at representative locations until either a voltage or thermal limit was violated, recording which constraint bound first and at what penetration level.

Results

Voltage rise was the binding constraint for distributed solar hosting capacity on the large majority of feeders in the sample, consistent with the physical mechanism of solar generation exporting power during low-load, high-voltage periods common around midday. Longer, more lightly loaded rural feeders showed voltage-bound hosting capacity limits at lower solar penetration than shorter, more heavily loaded urban feeders, where thermal constraints occasionally bound first due to existing conductor and transformer loading headroom.

EV charging hosting capacity showed a more even split between voltage and thermal binding constraints, driven largely by charging load coincidence: managed charging profiles that avoid existing feeder peak periods extended hosting capacity meaningfully under both constraint types compared to unmanaged charging concentrated in evening hours that coincide with existing residential peak demand.



Share of sampled feeders where each constraint type bound first for incremental distributed solar and EV charging hosting capacity respectively.

Discussion

These results suggest utilities investing in hosting capacity expansion for distributed solar should prioritize voltage regulation equipment and smart inverter reactive power capability over thermal upgrades on the majority of feeders, while EV charging hosting capacity investment should be paired with managed charging program design, since charging load coincidence with existing peak demand materially affects which and how much infrastructure investment is required.

This sample, while designed to represent a reasonable range of feeder characteristics, was drawn from a limited set of utility service territories, and results may not generalize directly to distribution systems with materially different load profiles, climate-driven demand patterns, or existing voltage regulation equipment baselines.

References

• EPRI, Distribution hosting capacity analysis methods

• NREL, DER hosting capacity research

• IEEE 1547, Distributed Energy Resource interconnection standard

Suggested Citation

Chen, W.; Ko, D. (2026). Distribution Grid Hosting Capacity for Distributed Solar and EV Charging. HydroLabs Engineering & Consulting Research Division.