

Granularity matters - Implications of detailed PV data for capacity expansion planning

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Extended Abstract

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Abstract Summary

Electricity system optimization models are essential tools for planning the energy transition, yet their outcomes depend critically on the quality of input data for decentralized generation. Looking at a case study in Switzerland, we show that the level of granularity of rooftop photovoltaic (RPV) data has a first-order effect on system-optimal investment decisions. Using a new high-resolution RPV dataset that resolves 48 orientation and tilt combinations, five size classes with differentiated costs, and 12 years of hourly generation profiles across the Swiss transmission grid, we find that a cost-minimizing optimizer invests in 15 GW of RPV when given this detailed representation, compared to only 0.4 GW with conventional, aggregated data with a single profile per grid node. A decomposition experiment shows that profile diversity is the primary driver of this increase, with cost differentiation further improving system efficiency. Under a binding 45 TWh domestic renewable production target, orientation diversity reduces curtailment nearly fivefold, while size-differentiated costs lower the estimated required investment costs by 13%. Aggregating RPV into a single profile per node obscures cost and generation heterogeneity that significantly affects investment outcomes and subsidy design. These findings likely extend to other decentralized generation and flexibility resources whose sub-node diversity is routinely averaged away in system models.

Presenting Author Biography

Jonas Savelsberg is a senior researcher and lecturer at ETH Zurich leading the power system modelling platform Nexus-e. He works on designing electricity markets for a renewable future and on the potential impacts of climate change on the electricity system.