NYSolarCast: Utility and Distributed Solar Power Forecasting for New York State

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Background and Objective

Along with several other states in the U.S., New York State (NYS) has set clean energy targets of 70% renewable energy (RE) generation by 2030 and 100% zero-emissions generation by 2040. To meet these aggressive targets, solar energy generation capacity must expand greatly, which increases the need for accurate solar power forecasts. Accurate forecasts both in intra-day (nowcast) and day-ahead time horizons are necessary for electric utilities and independent system operators, as they maintain grid stability and maximize RE use. Meeting this need for NYS, we developed a gridded solar power forecasting system called NYSolarCast.

Method

NYSolarCast predicts global horizontal irradiance (GHI) on a 3-km grid covering NYS, in addition to utility photovoltaic (UPV) power forecasts at select plants and distributed PV (DPV) power forecasts aggregated across zones. The statewide GHI forecasts are made by applying StatCast, a machine learning (ML) algorithm developed by NCAR, to nearly 3 years of GHI observations from pyranometers at all 126 NYS Mesonet stations and to gridded numerical weather prediction forecasts from the Weather Research and Forecasting model tuned for solar applications (WRF-Solar) and High-Resolution Rapid Refresh (HRRR) numerical weather prediction (NWP) models. The forecasts at each NYS Mesonet site are then blended outward into the rest of the grid, resulting in a much-improved GHI forecast in the nowcasting range than can be achieved simply from blending WRF-Solar and HRRR alone. Leveraging ML on historical UPV and DPV power production observations, the blended GHI forecasts are then used to produce 15-min UPV forecasts and 1-hourly DPV forecasts. Note that only the NYS Mesonet observations were available in real-time; the UPV and DPV data were made available in monthly installments.

Principal Findings

This study focuses on evaluating NYSolarCast GHI, UPV, and DPV intra-day (0–6-h) forecasts over a one-year period from May 2021–April 2022. Aggregating over this year, NYSolarCast beat both smart persistence and the NWP blend at all intra-day lead and valid times, with clearness index (Kt) leveling off around a mean absolute error (MAE) of 10–11% and near-zero bias except for a few sites that may require additional quality control for shading or snow cover issues. NYSolarCast GHI at UPV farms is nearly always better than StatCast GHI at the nearest NYS Mesonet station; this finding is especially valuable when real-time data from UPV farms are not available, as was the case here. Most UPV farms had a mean percentage error (MPE) of –2% to +2%, with a mean absolute percentage error (MAPE) of 9–12%. Additionally, when aggregating forecasts for 10 DPV sample sites statewide, the aggregated MAPE was < 10%.

Conclusion

NYSolarCast is an open-source solar forecasting system that generates intra-day and day-ahead forecasts of gridded GHI, plus UPV and DPV power. NYSolarCast is a flexible framework that can be adapted and configured for any region, state, or country, provided gridded NWP model forecasts and adequate historical and real-time data streams for meteorological and power production data, to enable ML model training and real-time forecasts.