Utility Scale Solar and Wind Power Variability in the Southwest United States

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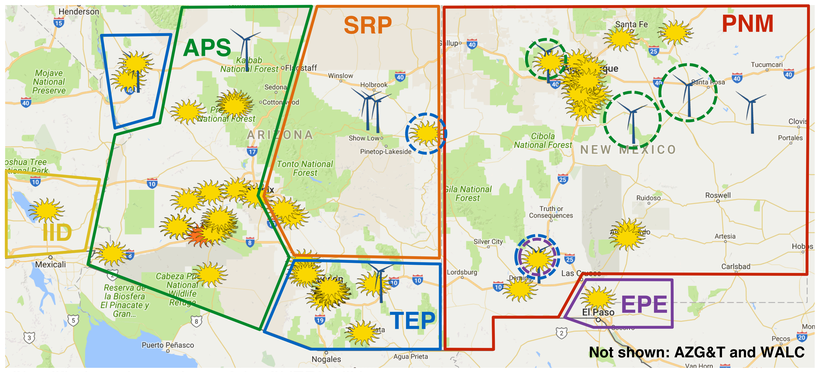
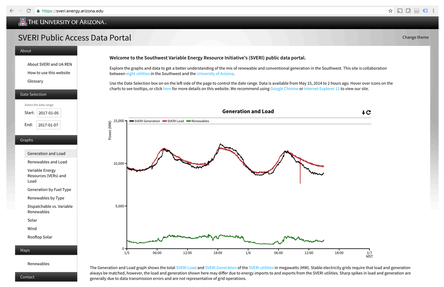
Introduction

We present observations and analysis of the variability of two years of utility scale solar and wind power from the 8 utility companies of the Southwest Variable Energy Resource Initiative (SVERI), primarily in Arizona and New Mexico.



Simplified service regions of the SVERI utilities

https://sveri.energy.arizona.edu

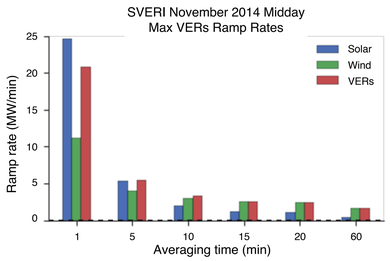


We developed a public website to share data from the SVERI utilities.

- Aggregate generation and load
- Breakdown of renewable and conventional generation
- Near real time
- Data downloads
- Map of utility renewables

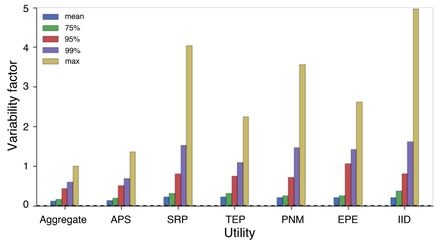
Samples of analysis products for SVERI

Quantify solar, wind, and solar+wind (VERs) ramp rates for low load times.



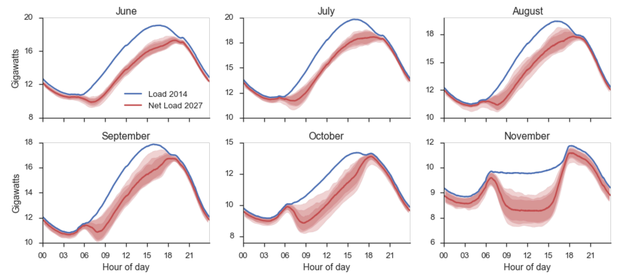
As averaging time increases, solar ramp rates decrease more quickly than wind ramp rates. See graphs below for ramp rates at other times.

Study on impact of geographic and technology diversity on aggregate variability.
more diversity ⟶ less variability



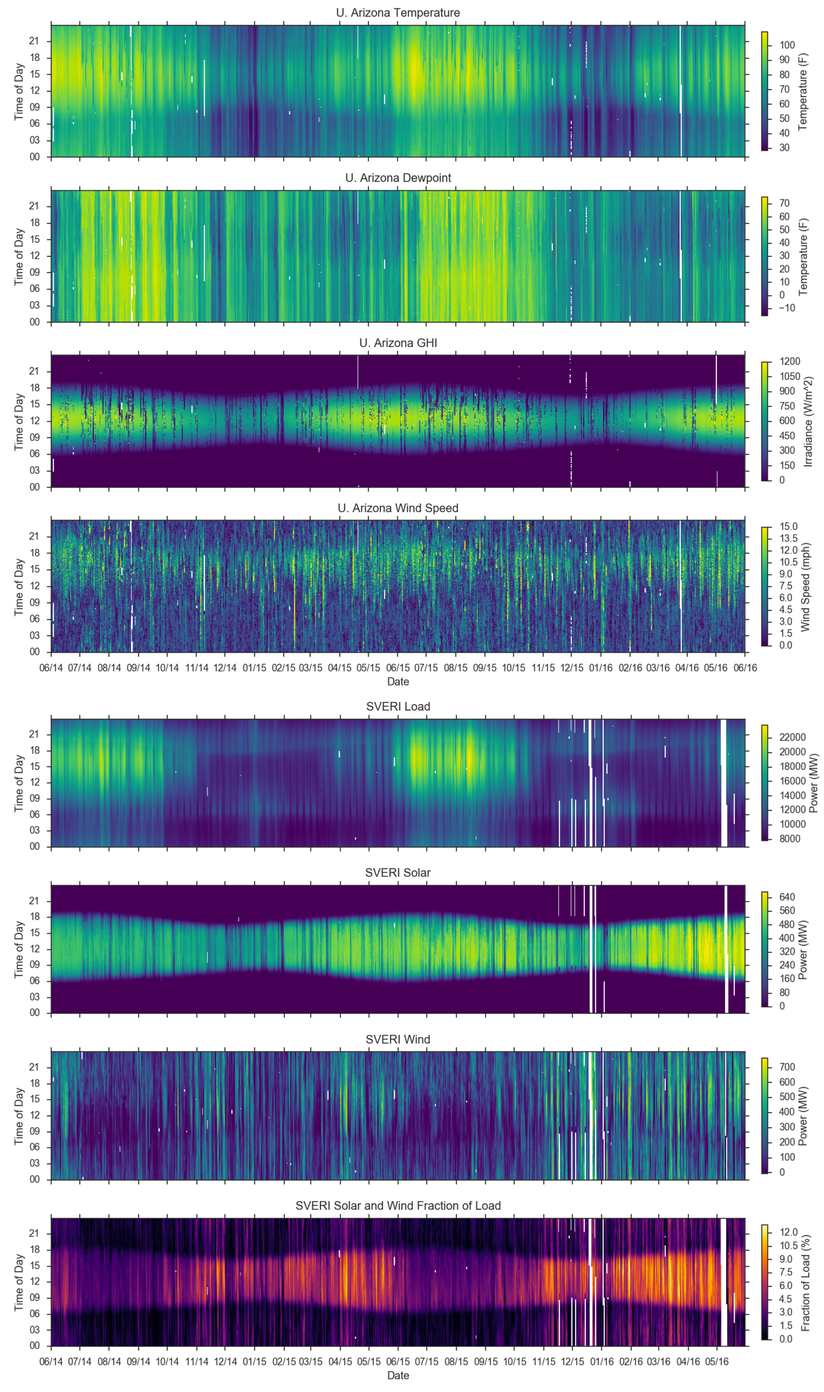
15 minute variability factors for the mean, 75th, 95th, 99th percentiles, and maximum for each SVERI utility.
factor = utility ramp stat. / max SVERI aggregate ramp

SVERI Aggregate 2027 Net Load Projections



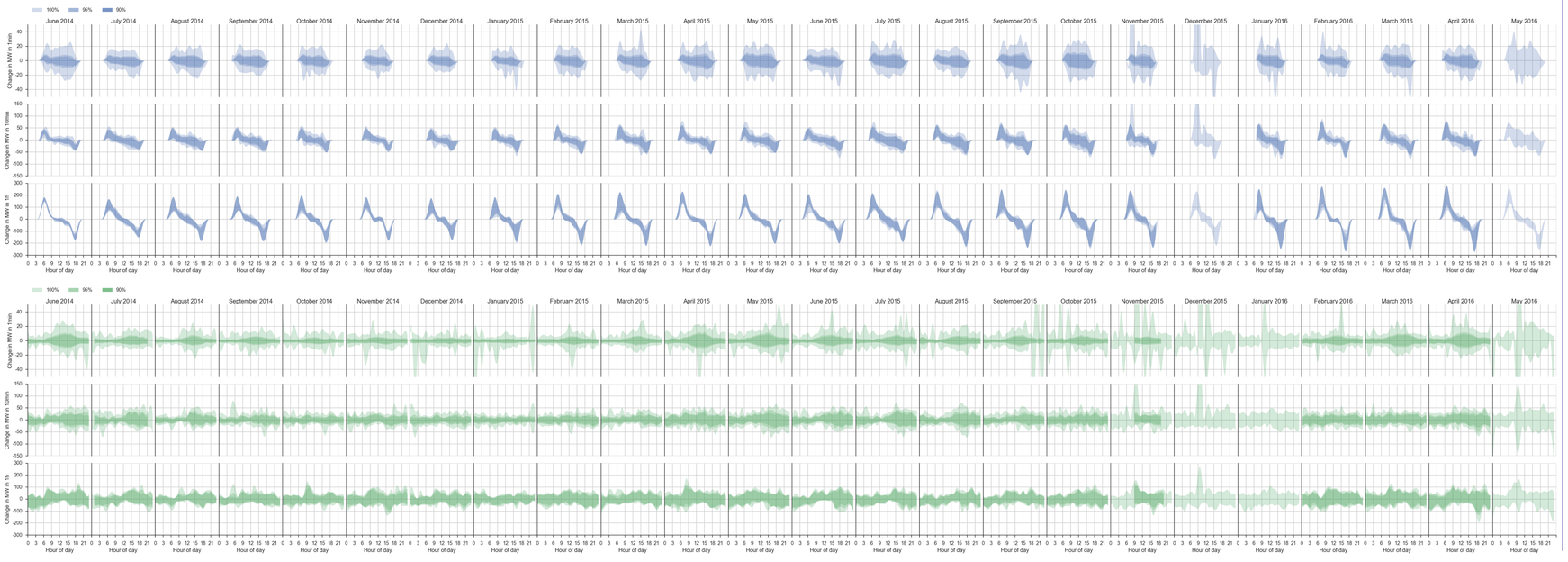
SVERI average 2014 load (blue lines), projected average 2027 net load (red line), and projected 2027 net load range (red area). The shading shows the range from the minimum and maximum, 5th and 95th percentile, and 10th and 90th percentile of VERs generation and thus net load variation. Here, net load is the load that must be served by non-VERs. Analysis does not account for behind the meter generation.

Heatmaps of Arizona weather and SVERI power data



Solar and wind power ramp rates

Monthly averages of rates of change in SVERI aggregate solar power (blue) and wind power (green) are shown below. We resampled 10 second instantaneous meter data to 1 minute, 10 minute, and 1 hour averages, then calculated their gradients. We grouped the gradients by month and hour, then calculated percentiles for the upward and downward ramps. SVERI solar variability that arises from changes in cloud cover tends to be greatest when looking at small (under five minute) times scales, while changes over 1 hour time scales are mostly attributable to solar position rather than clouds. SVERI solar power variability also exhibits distinct seasonal trends. SVERI wind power variability increases as the time scale increases from 1 minute to 60 minutes and exhibits less pronounced seasonal trends.



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The SVERI utilities