U. Arizona Renewable Power Forecasting

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- Aggregate gen. and load
- 8 utilities in the southwest
- 1.2 GW of renewables
- Near real time
- Data downloads
- Map of utility renewables

The Renewables and Load graph shows the total SVERI Load, the total SVERI renewable generation, and the Net Load after Renewables. The Net Load after Renewables is the load that must be met using conventional resources such as coal, gas, and nuclear or by importing energy from other regions of the Western Interconnection. Net Load after Renewables is calculated by subtracting the total renewable generation from the total load.

Tip: hover your pointer over one of the lines on the graph to get its value at that point in time.
SVERI renewables

from sveri.uaren.org
TEP’s Solar Power Variability

- 50 MW ramp in 15 min
- Many 25 MW ramps in 1 min → Area Control Errors (ACE)
- Load 1.5 GW
- Reserves 100 MW
TEP 2014 Net Load Range

TEP June

Gigawatts

Hour of day

Load 2014
Net Load 2014

TEP November

Gigawatts

Hour of day
TEP 2017 Net Load Range

TEP June

TEP November
TEP 2027 Net Load Range

- TEP June
- TEP November

Gigawatts

Hour of day

Load 2014
Net Load 2027
SVERI Net Load

The graphs show the net load for SVERI across different months from June to November. Each graph indicates the load and net load with a blue line for load, a green line for net load, and a red line for net load 2027. The y-axis represents gigawatts, and the x-axis represents the hour of the day.
SVERI solar variability

Change in MW in 1min

Change in MW in 10min

Change in MW in 1h

Hour of day
SVERI wind variability
UA Forecasting Website for TEP + APS
Numerical Weather Prediction at UA

• Model highlights
  – 5.4 km outer domain, 1.8 km inner domain
  – Initialized on the 6Z and 12Z GFS and NAM
  – Most days include 12 RAP initialization (esp. in summer)

• Local challenges include:
  – Mountains + moisture + heating = monsoon storms
  – Unreliable initialization data from Mexico
  – Extreme planetary boundary layer heights
  – Rapidly changing land/surface characteristics

• 1.8 km resolution, 3 minute outputs of:
  – GHI, DNI, 10 m wind, 80 m wind, temp

WRF configuration details:
• RRTMG
• Morrison 2 mom. or SBUYLIN
• Bougeault-Lacarre or ACM2
• Noah LSM
UA WRF forecasts available at atmo.arizona.edu

Contact me for access to raw data

Arizona Regional WRF Model Data

Model Derived Forecasts
SE AZ Forecast, Phx Area Forecast, AM Optical Depth

Model Discussion
During the monsoon season and for significant weather events, a model discussion may be available.

Current Discussion, Previous Discussion

Model Products

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<th>06z AZ WRF-GFS</th>
<th>06z AZ WRF-NAM</th>
<th>12z AZ WRF-NAM</th>
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Animation available at: http://forecasting.uaren.org

Blue: low elevation
Red: high elevation
UA vs. HRRR Tucson GHI

MAE:
15 minutes:
HRRR: 113, UA: 51, UA Day 2: 100, UA Day 3: nan
1 hour:
HRRR: 98, UA: 33, UA Day 2: 89, UA Day 3: nan
UA vs. HRRR Tucson GHI

MAE:
15 minutes:
HRRR: 28, UA: 78, UA Day 2: nan, UA Day 3: 21

1 hour:
HRRR: 26, UA: 70, UA Day 2: nan, UA Day 3: 16
Not a fair comparison because NCEP HRRR does not use the correct eqn. of time
So, we subtracted 15 minutes from HRRR time for approximate correction for these months
First HRRR point also discarded

Oct-Dec average of the daily average of 15 minute or 1 hour MAEs
Limit analysis to large (MAE > 60) errors.
Eliminates clear days.
Helps HRRR, relatively, since it is much worse than UA on clear days.
UA day 3 still outperforming NCEP HRRR
Satellite Imagery

Animation available at: http://forecasting.uaren.org
Satellite Derived Solar Irradiance

Animation available at: http://forecasting.uaren.org

Blue: low solar power
Red: high solar power
Sensor network forecasting

Partnered with local PV installer Technicians for Sustainability to obtain access to real-time (5 min latency) data feeds of residential PV systems.

Homebuilt irradiance sensors will cell modems (see A. Lorenzo, AMS 2015).

Network of rooftop solar data and irradiance sensors provides most accurate 30 minute forecasts.
Network Forecast

Animation available at: http://forecasting.uaren.org
UA Renewable Power Forecasting

UA forecasting for TEP and APS:
- **3 day** forecasts of solar and wind production using **WRF**. (operational)
- **2 hour** forecasts of solar production (utility and behind the meter) using **GOES**. (development)
- **1 hour** forecasts of solar production (utility and behind the meter) using a **Network of Irradiance Sensors**. (operational on sub-domain)

UA forecasting for Idaho Power Company:
- 1-10 day WRF wind forecasts
- Also collaborating with NCAR, IPC on cloud seeding (hydro)

UA forecasting for SVERI
- Outer domain 6Z runs for every utility scale site
Thanks to our funding agencies

Major support from

DOE EERE
Postdoctoral Fellowship

Additional support from

The SVERI utilities

Arizona Department of Environmental Quality

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