Real-Time Renewable Power Forecasting

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The Problem: 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
The Problem: TEP’s Solar Power Variability

[Graph showing TEP Load and Utility Scale Renewables]

- Load
- Load – Utility PV generation
- Utility PV generation
The Problem:
TEP’s Solar Power Variability

Morning
Steady PV
Steady load
Small ACE

Afternoon
Noisy PV
Noisy load due to
behind the meter gen.
fluctuations
Large ACE
The Problem:
TEP’s Solar Power Variability

These data show about 10% peak PV penetration. What will the load and net load look like with > 50% peak penetration?
The Solution: UA + TEP developing renewables forecasts

How can forecasts help utilities keep energy costs low and maintain grid reliability?

- Better predictions of generation and load requirements
- Improve energy market trading strategies
- Schedule more efficient generators (e.g. combined cycle vs. combustion turbine)
- Reduce costs associated with generator starts
- Defer maintenance associated with excessive generator set point seeking
- Optimize the use of battery storage

UA is providing TEP with forecasts as we speak!
Forecasting Website for TEP

Forecasts for TEP EMS sites, irradiance sensors, and rooftop PV
Different forecasting methods work better at different time scales.
Numerical Weather Prediction at UA

- Local/regional knowledge of weather is extremely important

- State of the art model modified to better represent the unique characteristics of southwestern U.S. weather
  - Mountains + moisture + heating = monsoon storms
  - Unreliable initialization data from Mexico
  - Extreme planetary boundary layer heights
  - Rapidly changing land/surface characteristics

- Five model runs per day, out to 72 hours in advance

- 1.8 km resolution, 3 minute outputs of:
  - GHI, DNI, 10 m wind, 80 m wind, temp
Blue: low elevation
Red: high elevation

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

GHI  02-19-2014 1445 UTC  W m⁻²

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

Blue: low solar power
Red: high solar power
PV Cloud Detection Network

UA Science and Technology Park
20 MW of Solar PV

Network of irradiance sensors provides 15-30 minute ahead warnings of clouds
Network Forecast

Animation available at: http://forecasting.uaren.org
Behind the Meter Visibility and Forecasting

Partnered with Technicians for Sustainability to obtain access to real-time data feeds of residential PV systems.
The Solution:
UA + TEP developing renewables forecasts

UA forecasting methods for TEP:
- **3 day** ahead forecasts of solar and wind production using **Numerical Weather Models**.
- **2 hour** ahead forecasts of solar production (utility and behind the meter) using **Satellite Imagery**.
- **1 hour** ahead forecasts of solar production (utility and behind the meter) using a **Network of Irradiance Sensors**.

- Web site with forecasts
- Spreadsheet files with forecasts

Working with APS, SRP, PNM, IID, EPE, IPC to explore forecasting in their service territories
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UA + TEP developing renewables forecasts

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