Progress and Needs for Renewable Energy Forecasting

IEA Wind Task 51 Workshop

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Bulk System Forecast Uses

Similar time frames for distribution

- Met: Climatological Forecast, Hindcasts
- Renewables: Grid Connections + Adoption forecast

DECISION

- Nuclear Fuel Cycle
- Production Cost Modeling
- Transmission & Generation Connection
- Fuel Hedging

FORECAST

- YEAR AHEAD
- SEASON AHEAD
- WEEK / DAY AHEAD
- REAL TIME

Met: Forecast Providers

- Asset Maintenance
- Fuels Optimization
- Ancillary Service Procurement
- Generation Scheduling
- Congestion Management
Emerging Challenges for Forecasts

**Plant Operations**
- Hybridization with storage, solar
- Active wake steering, plant optimization

**Extreme Conditions**
- Operational decision making in stressful grid conditions
- Impact of wildfire, storm, flood

**End Use Applications**
- Integration of forecasts into ops planning / balancing
- Valuation of forecasts

Deeper integration into system operations
NWP Highlights

North American Models
- Extended horizons for rapid refresh (HRRR, RAP) models
- Assimilation of satellite data
- Cloud physics – improves subgrid mesh

European Models
- Improved cloud, precipitation modeling
- Assimilation of satellite data
- Increased vertical resolution

Wildfire and Smoke
- NOAA HRRR-Smoke and RAP-Smoke models

Domains of the RAP (13-km resolution) and HRRR (3-km resolution) models. Source: rapidrefresh.noaa.gov

Sample HRRR-Smoke forecast of vertically integrated smoke from a fire near Santa Barbara, CA on October 12, 2021. Source: rapidrefresh.noaa.gov/hrrr/HRRRsmoke/
Forecast in Operator Decisions Highlights

»Support operator decision making without information overload
»Primarily involves incorporating weather forecasts

Robust Data Pipeline and Storage

New Standardization for Color/Actions Schemas

Integration with EMS Alarms & Alerts

Incorporating Condition with Security Analysis

Standardized forecast Performance and Metrics (Establish Baselines)
High-risk Scenarios Often Not Peak Cases  
Thus, Missing in Operations Planning Studies

Days Out Forecasts Help Develop Scenarios to Improve Reliability

Expected Topology
Load, VER, DER Distributions
Weather Event Likelihood
Scenario Development
Days-Weeks Out Outage Studies

High risk scenarios often not peak cases. Thus, missing in operations planning studies.
Solar Forecast Arbiter: https://solarforecastarbiter.org/

impartial, repeatable & auditable forecast evaluation tool
Solar Forecast Arbiter

- online platform that provides transparent evaluation of forecast performance
  - user friendly, with graphical and API interfaces
  - supports anonymized forecast trials
  - open-source code

- currently focused on solar, but is generalizing to cover solar, wind and load forecasts

- will transition to EPRI management starting mid-2022 *
  - will be part of a Forecasting Users Group (UG) for utilities/ISOs/RTOs, but still available to the public
  - UG will include annual meetings, updates on performance, support in benchmarks and use

*EPRI was one of the co-developers, along with University of Arizona (lead), Sandia and Sharply Focused, with funding provided by DOE

https://solarforecastarbiter.org/

Contact David Larson <dlarson@epri.com> or Aidan Tuohy <atuohy@epri.com> for more info
Why use the Forecast Arbiter?

- standardized process to evaluate forecasts
- anonymized, multi-vendor forecast trials
- track forecast accuracy over time
- automated reports with wide range of error metrics
- support for both deterministic and probabilistic forecasts
- benchmark forecasts and reference data for 200+ sites already included
- ...and many more features!

Figure: Screenshot of sample report.
Probabilistic Forecasts

» Useful for providing additional awareness and insight on uncertainty
» Working on methods to incorporate these directly into decision processes
» Balancing authority is main focus now, but similar concepts could be applied to others
Software Tool to Support Integration with Operations

Currently working with participating utilities to refine the platform:

- Reserve requirements for different risk preferences and methods
- Scenario generation for UC
- Link to unit commitment/economic dispatch
- Visualize and assess forecasts and reserves

**SMP to be released as open-source at end of DOE project**
Use of Probabilistic Forecasts in Operations

Use #1: Directly use to set reserves
  » Set operating reserves based on probabilistic forecasts – different methods can be used

Use #2: Scenario Generation for UC or reserves
  » Transform probabilistic info into scenarios, which can be used in a UC model to allow for stochastic UC
Probabilistic Scenarios to Reserve Requirements

» From scenarios to reserve requirements

Given the explanatory variable, generate subsets (\(S^{up}, S^{dn}\)) of extreme scenarios

Method 1
Consider all scenarios and historical data

Method 2
Extreme scenarios and historical data

Method 3
Utility Case study results (Hawaiian Electric)

» Using probabilistic forecasts to set reserves:
  - increased reserves during middle of the day (when solar generation peaks)
  - did not conclusively increase or decrease costs, but led to more consistent operating costs week-to-week
  - improved operating conditions, including lower head room risk (< 1%) and more consistent frequency compliance

Day where prob. forecasts increased reserves, but lowered costs.

Prob. forecasts (orange) led to lower risk (< 1%) for all weeks simulated.
EPRI Short Term Forecast Integration Efforts

- Renewable Forecasting Landscape Document
- Behind the Meter PV Impact on Load Forecast
- Solar Forecast Performance Utility Trials
- Operational Probabilistic Tools for Solar Uncertainty
- NY Sky Imager Deployment and Advanced Forecasts
- California Forecasting Improvement Projects
- Artificial Neural Network Short Term Load Forecaster
Together...Shaping the Future of Electricity
For more info on the Forecast Arbiter

» ESIG blog post: https://www.esig.energy/the-solar-forecast-arbiter/

» webcast (~14-min): https://youtu.be/oqidNhIAkAo

» main website: https://solarforecastarbiter.org/