

Introduction to Forecasting and Operations

ESIG Meteorology & Market Design Tutorial

Aidan Tuohy, Erik Ela
EPRI Grid Operations and Planning

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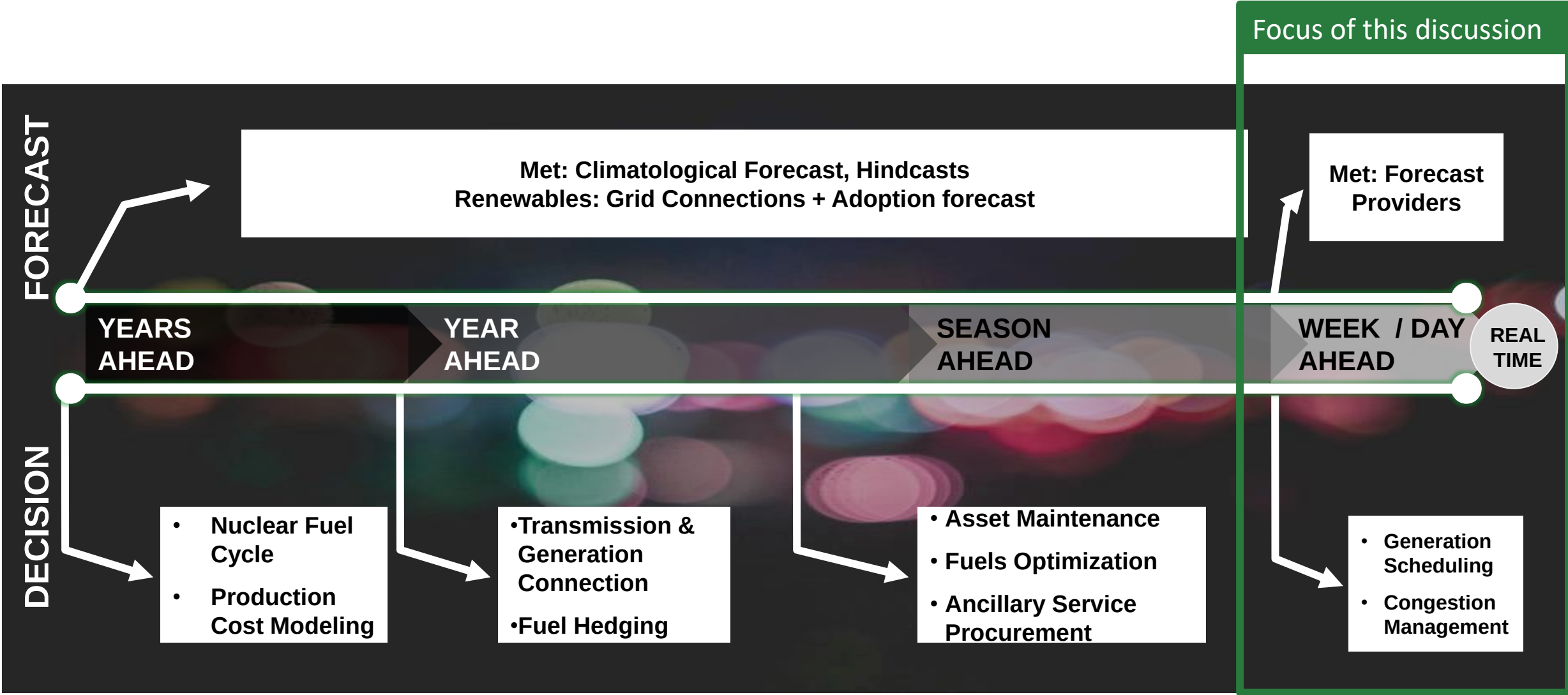


Agenda

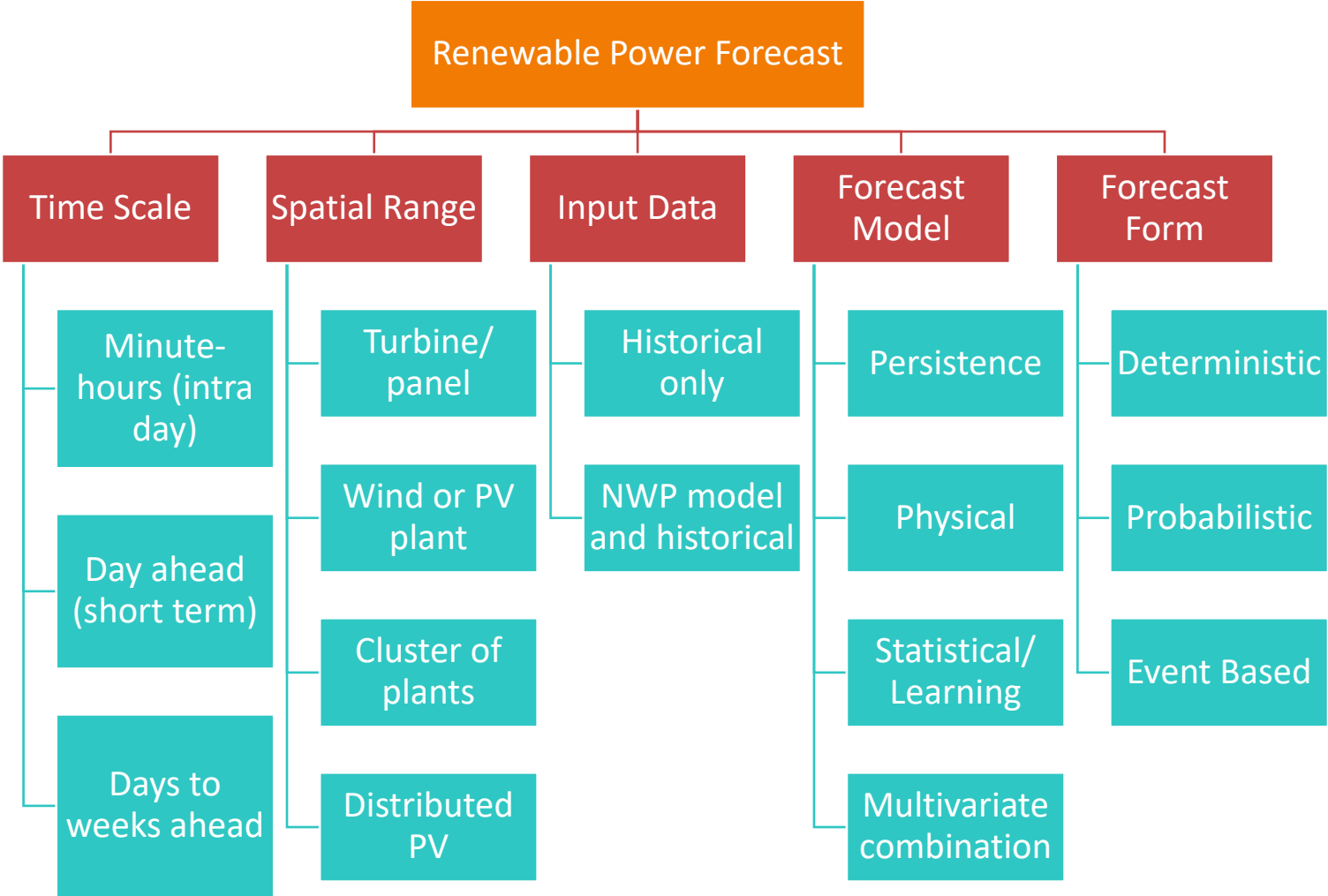
- How forecasting aligns with system operations (Aidan)
- Market Operations Overview and Role of storage, Hybrids and DER (Erik)
- Panel session
 - Forecasting Hybrid and Co-Locate Resources, Amber Motley, CAISO
 - Market participation of hybrid resources, Mark Ahlstrom, NextEra Energy
- Discussion, Q&A



Bulk System Forecast Uses



Forecast Classification



Adopted from
IEC TR 63043
“Renewable energy
power forecasting
technology”, 2020

Any renewable forecast will be combination of these

Terminology across different functions

Forecasting

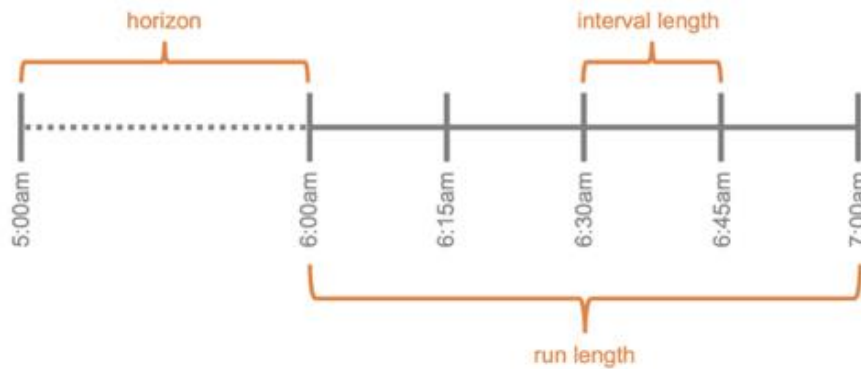
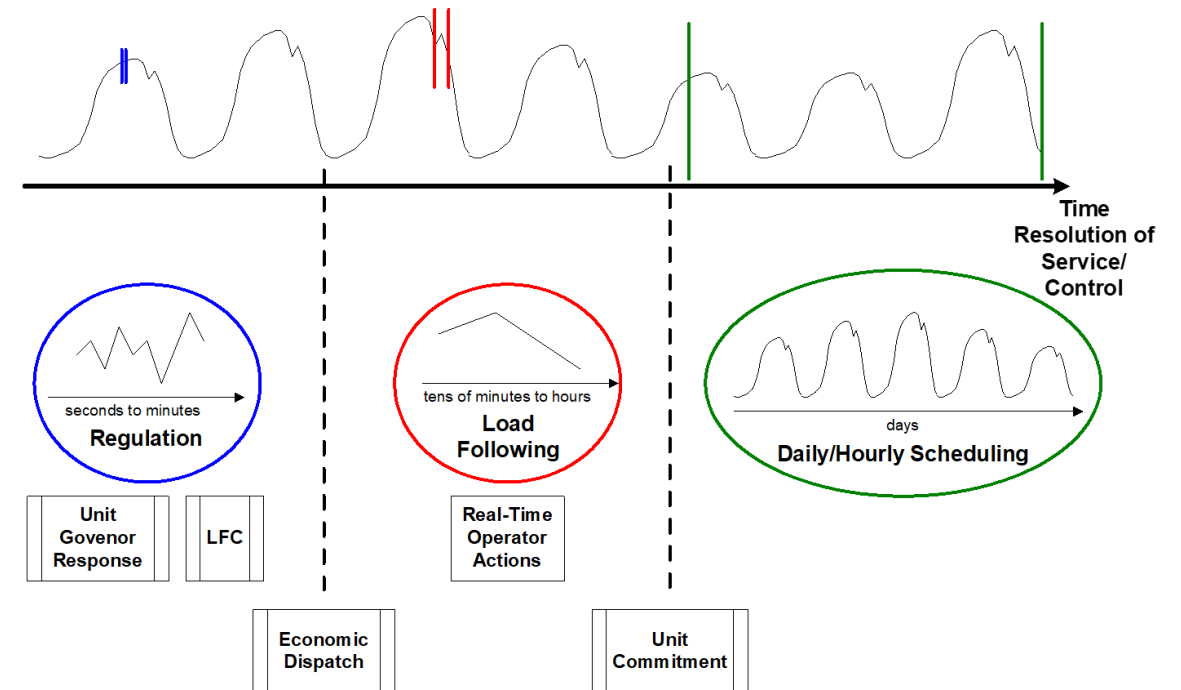


Figure 1-1 Illustration of a forecast issued at 5:00am with a horizon of 1-hour, run length of 1 hour and four 15-minute intervals.

System Operations

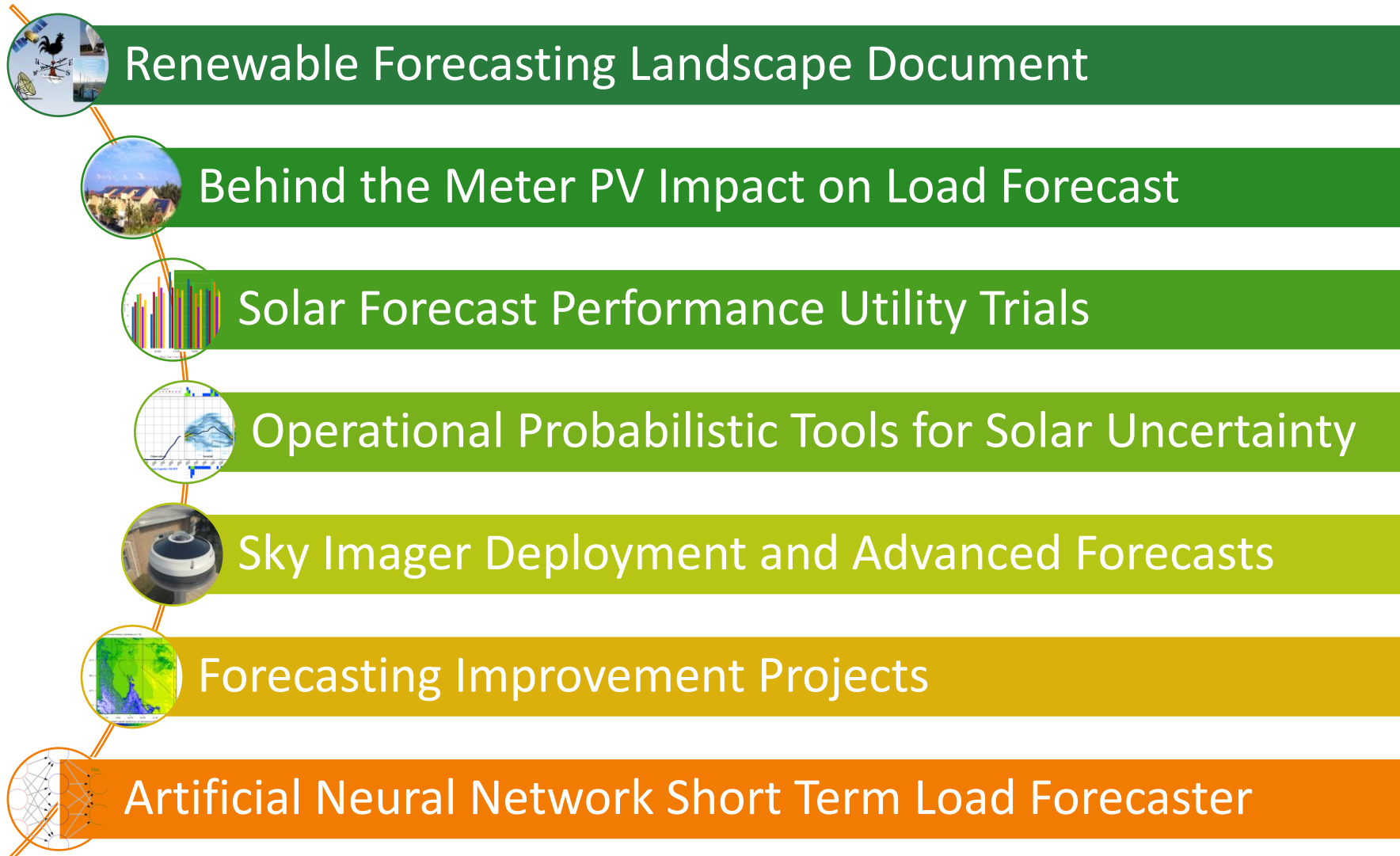


Questions for the audience

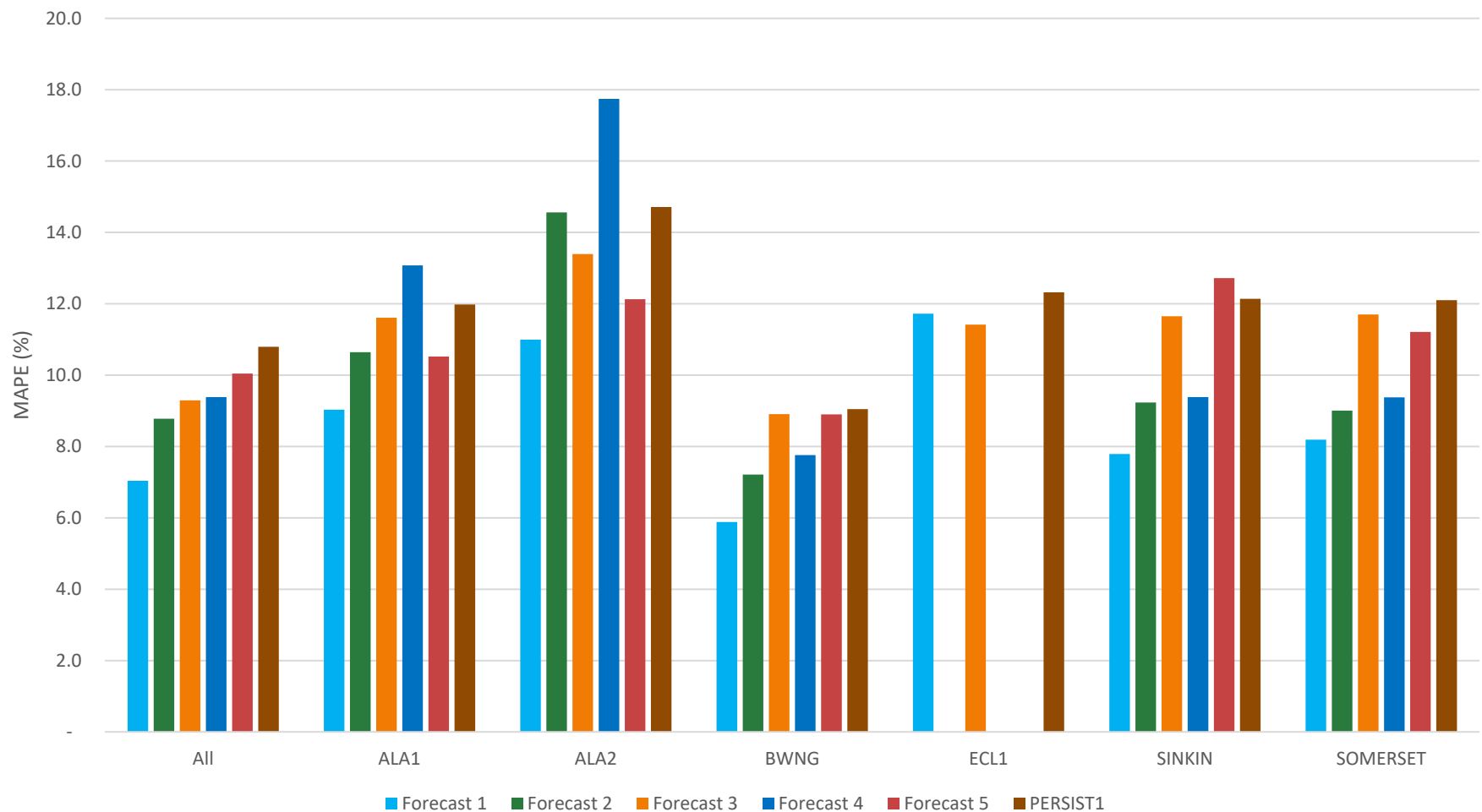
- Is your expertise on forecasting, market operations, both or none?
- Do you already have a good idea of how forecasts are used in operations or do you want to know more in that area?
- Do you interact with forecasts often in your day job?
- Do you interact with market operations often in your day job?
- For emerging resources such as storage, DER, hybrids, how important do you think forecasting is? More/less/about the same as for how we think about VRE



EPRI Short Term Forecast Integration Efforts

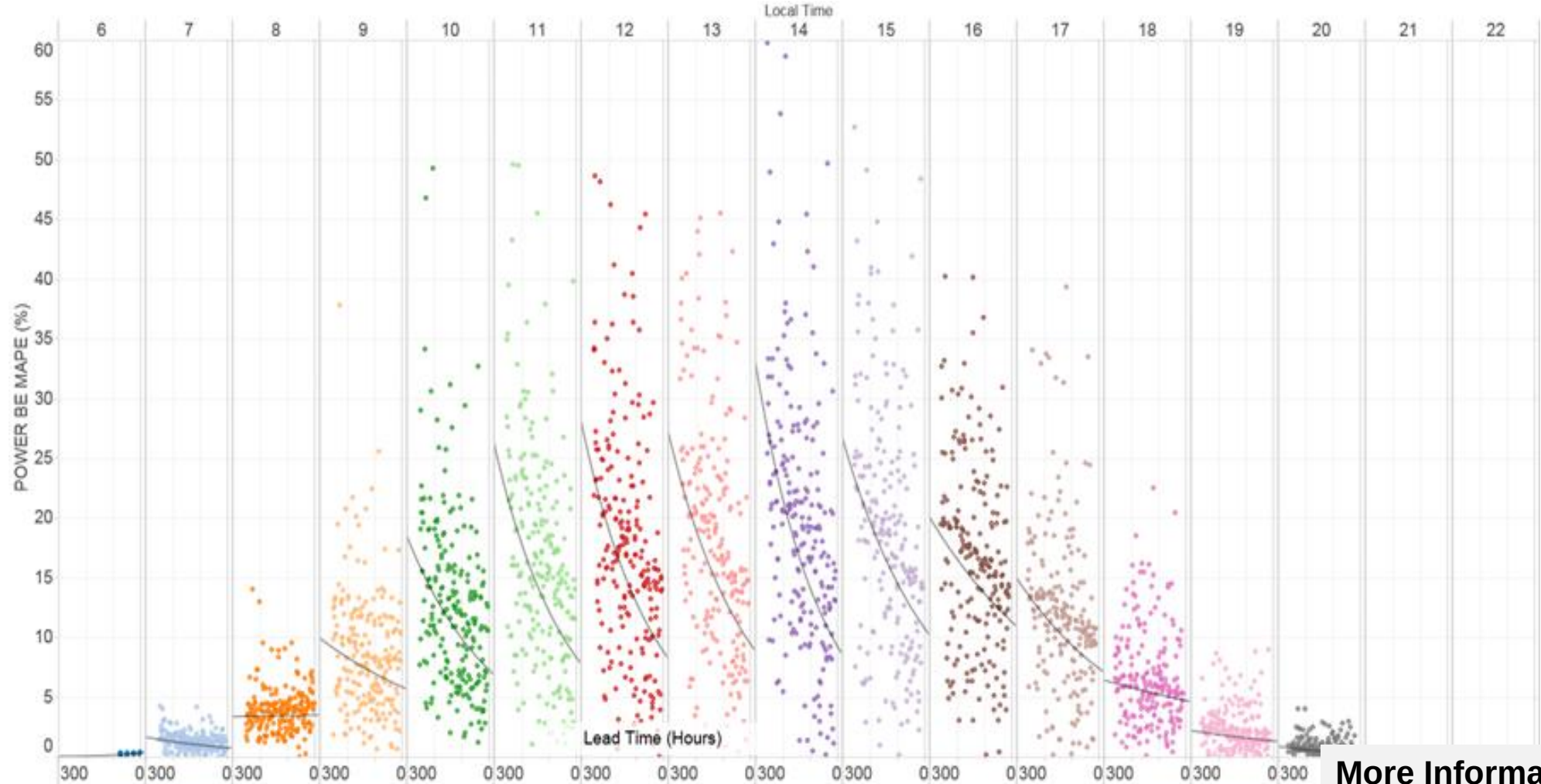


Solar forecast performance across vendors and locations



Performance varies widely for different forecasters and across solar farms, due to data availability and technology

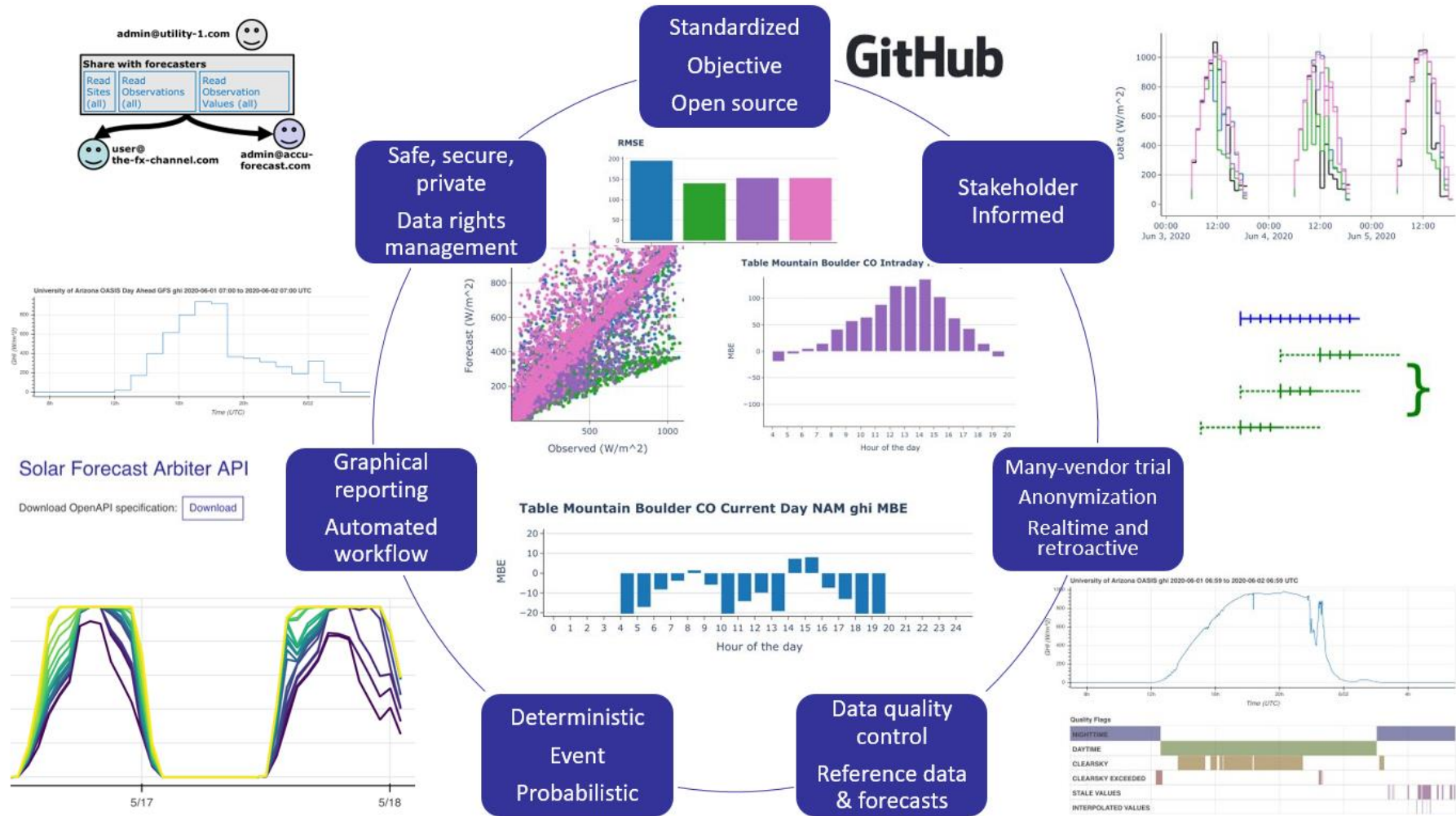
More uncertainty in performance than summary metrics show



More Information:

Solar Power Forecasting for Grid Operations: Evaluation of Commercial Providers, EPRI, 3002012135

Forecast Arbiter: <https://solarforecastarbiter.org/>



impartial, repeatable & auditable forecast evaluation tool

Forecasting Trends

Solar

- Satellite imagery for intra-day (<6h)
- Deep learning interest (research and vendors)
- Models not relying on measured power data
- Sub-hourly resolution
- Probabilistic forecasts

Wind

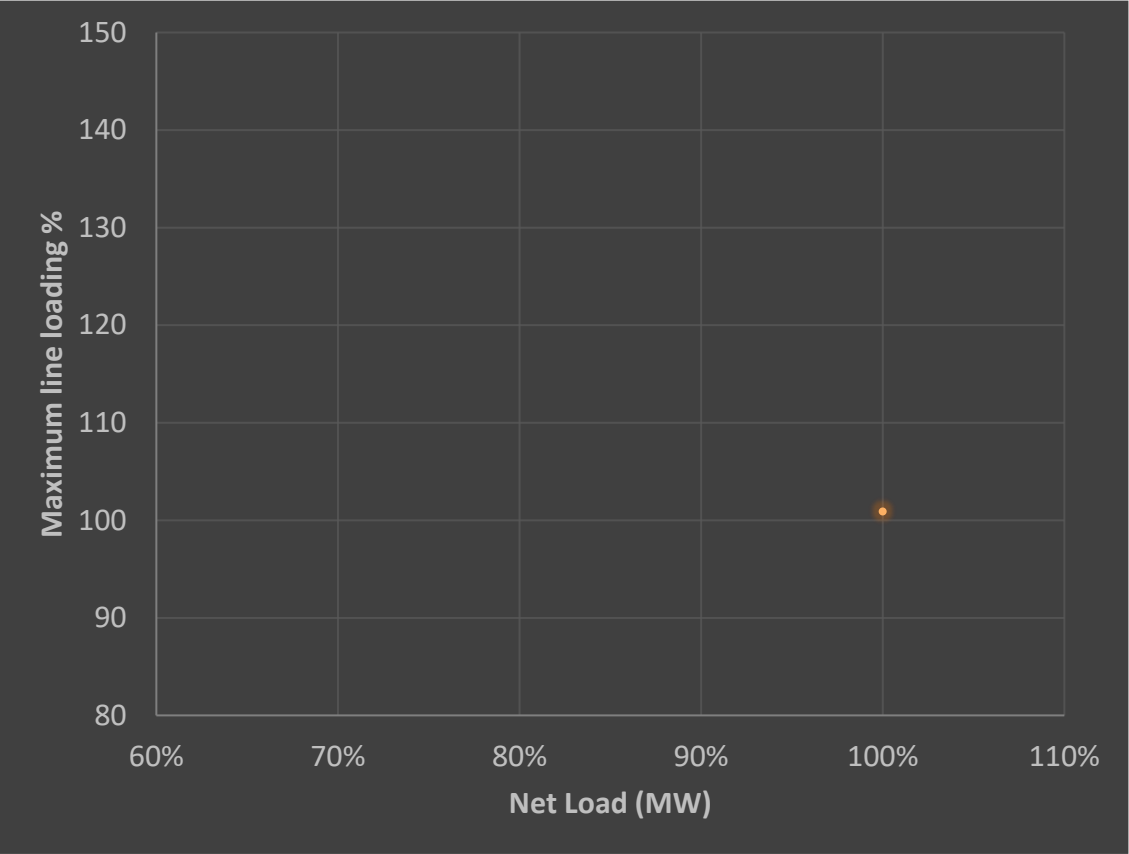
- Probabilistic forecasts
- Offshore wind forecast emphasis
- Deep learning interest (research and vendors)

Load

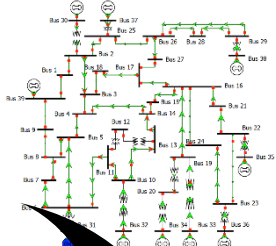
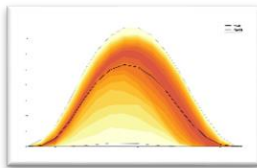
- Increase spatial and dist level forecast
- Accounting for behind-the-meter solar
- Accounting for batteries/DER
- Changing demand profile (COVID-19, remote work)
- Extreme events

Days Out Forecasts Help Develop Scenarios to Improve Reliability

High-risk Scenarios Often Not Peak Cases
Thus, Missing in Operations Planning Studies

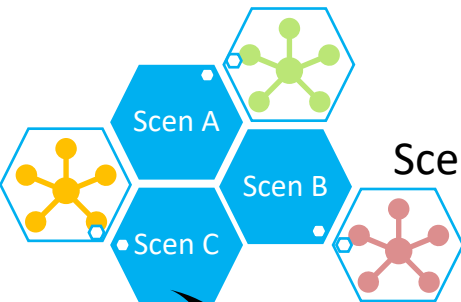
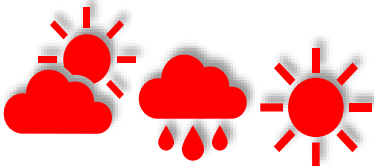


Load, VER, DER
Distributions

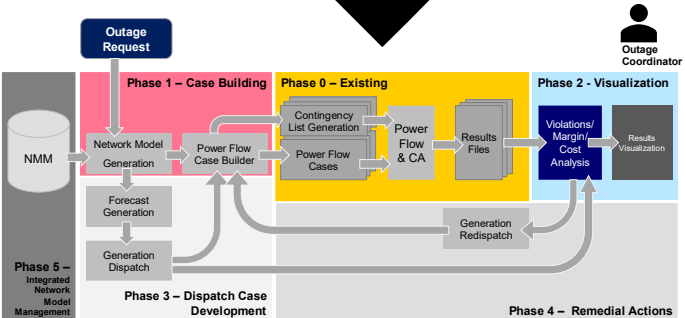


Expected Topology

Weather Event Likelihood



Scenario Development

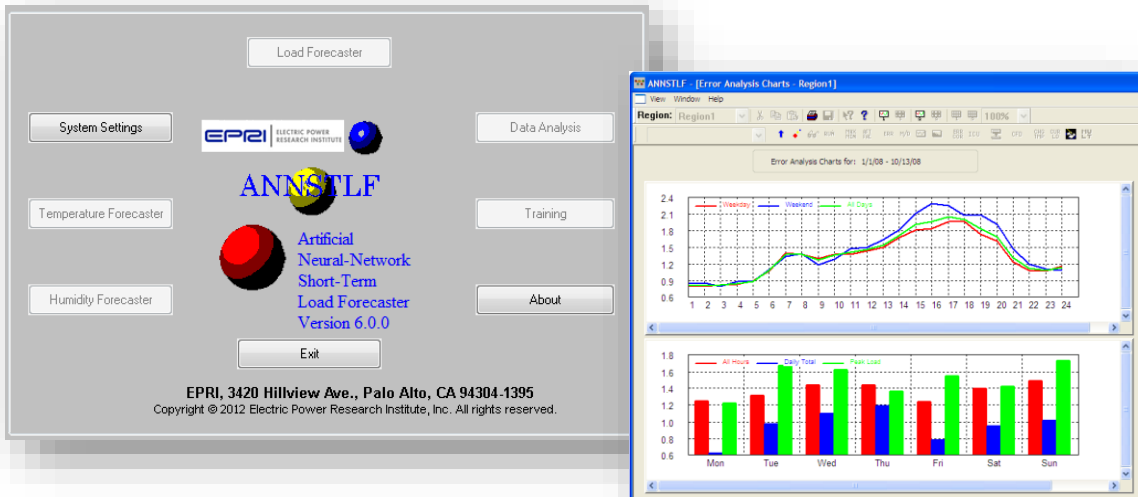


Days-Weeks Out
Outage Studies

Load Forecasting – Before Adding DER/Behind the Meter

History

- Continuous 1–7 day region-level load
- 20+ years of R&D
 - First NN-based load forecaster
- Used by many operators & traders
 - Ongoing supp 12+ members
- Competitive performance
 - 3% MAPE or less
- Data required
 - Single point actuals & forecasts
 - Temp, Humidity
 - Holidays, half-holidays



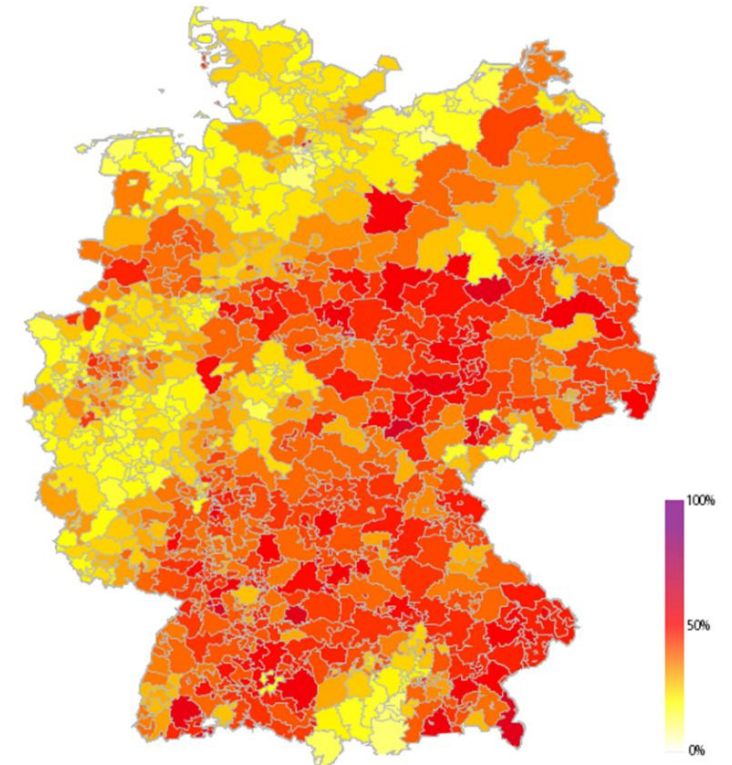
Example Annual Performance for 3 Regions

Load Region	ANNSTLF MAPE		Combined ANNSTLF & HbH-ANNSTLF MAPE	
	Peak Load	All Hours	Peak Load	All Hours
APS	2.3	2.4	2.1	2.2
ISONE	2.4	2.0	2.1	1.7
ALTW	2.8	2.5	2.3	2.1

Operational load forecaster benefiting members for over 20 years

Understanding Impacts of Distributed PV on Load Forecasting

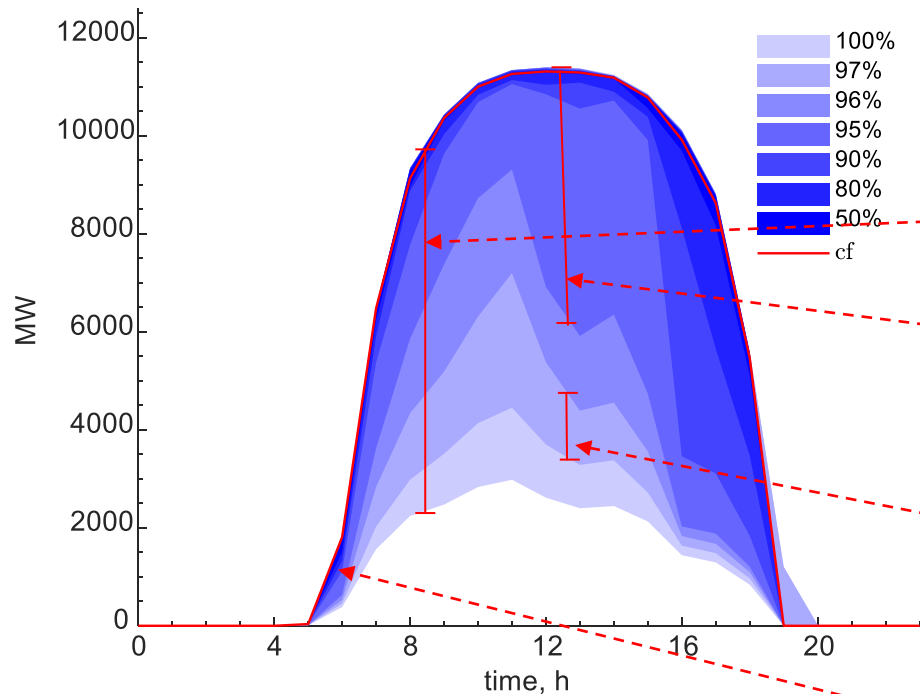
- Continued growth of distributed PV (DPV) is changing loads at all levels (customer, utility, ISO/RTO)
- Forecasting approaches for traditional loads are mature, but not designed for high levels of DPV
- Need to study effects now to plan for future:
 - Data sources
 - Infrastructure
 - Forecast methodologies



Real Time estimation of solar power in Germany (provided by energy & meteo)

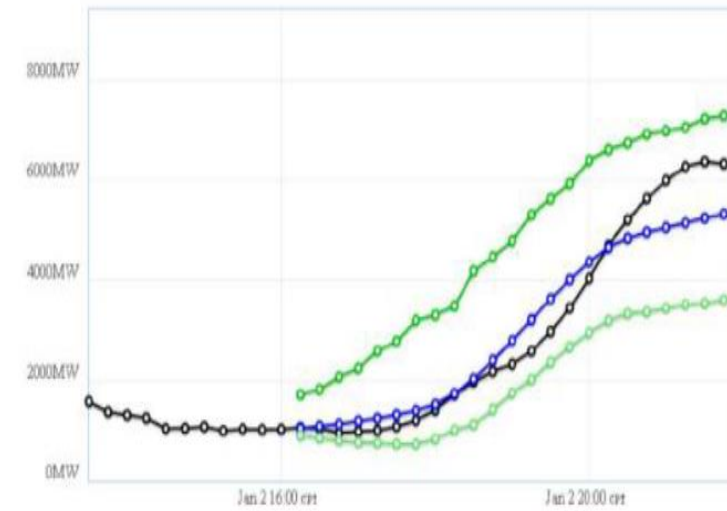
Probabilistic Forecasts

- Probabilistic forecasts provide users with valuable information on uncertainty
- They are composed of probabilistic thresholds in which the variables are expected to materialize:
 - A 100% threshold indicates total certainty of the variable being within the band
 - Lower probability thresholds indicate that the likelihood of the variable being within a narrower band (e.g., 95%)
 - Area between thresholds represent the probability of the variable materializing only in that space (e.g., $(97-96)/2 = 0.5\%$)
 - The redline represents the central expected forecast

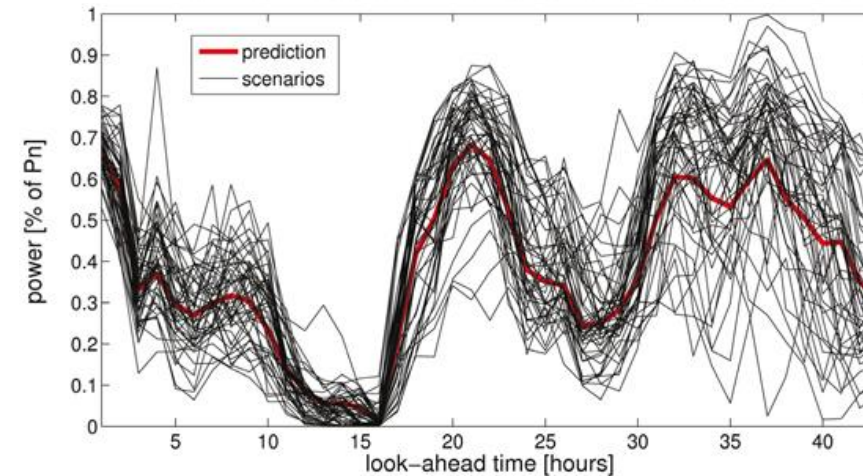


Why use probabilistic forecasts?

- Takes advantage of risk-based methods such as stochastic programming
- Captures outliers (assuming data is representative)
- Should be more economically efficient while can also be more reliable than traditional methods
- May give us better rationale for responding to some extreme events, e.g. extreme cold



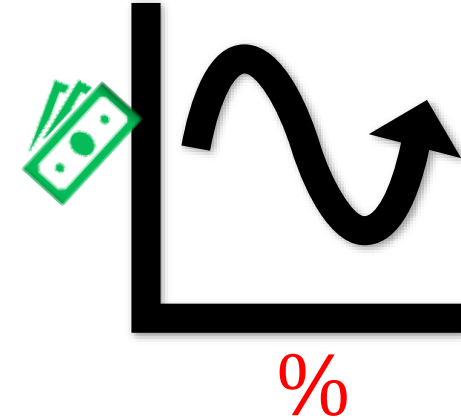
Source: David Maggio, Using probabilistic information in real life, 2011 UWIG Forecasting Workshop



Quantifying Forecast Value

What is the value of improving MAPE by 0.1%?

One forecast vendor has a lower MAPE but another better forecasts the peak, which is better?



Group 1 Analytical Formula

- Value as a function of forecast error
- E.g., \$ per 1% MAPE reduction
- Usually based on historical values or expert estimates

Group 2 Production-cost Simulations

- Simulate market operation ED/UC
- Feed forecast scenarios into simulations
- Compare resulting economic impacts

Key Takeaways

- Forecasting is widely used across all operations practices
 - While scheduling is most obvious, other applications also relevant
 - Increasing value for forecasting
- Linking the decision making process with forecasts is important
 - Keeping decision until later can help get a better forecast
 - Needs to be traded off with operating decision process on system side
- Increasingly complex data and different decision makers
 - Behind the meter solar, distributed storage, hybrid plants all bring their own complexities
 - Probabilistic information becomes more important for decision makers

**As the system changes, forecasting applications need to keep up
Focus today on storage, DER, hybrids and other newer issues in forecasting**

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