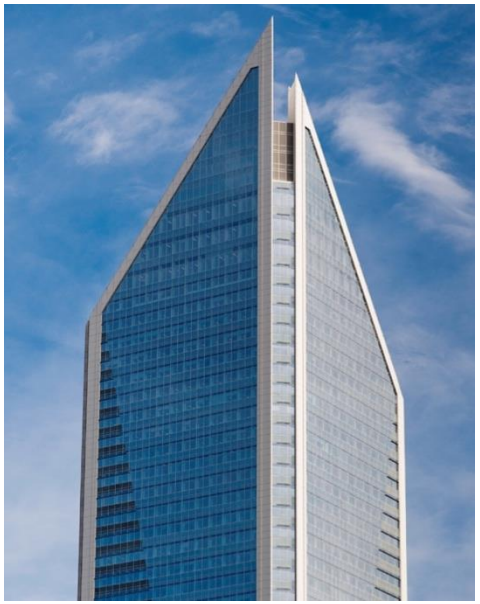
Meteorology & Market Design Workshop: Session 8: Forecasting, Reserve Requirements and System Operations

Use of Forecasts in Reserve Allocation

Presented by Rhett Trease 6/22/2021








ISOP Integrated System & Operations Planning

DUKE ENERGY®

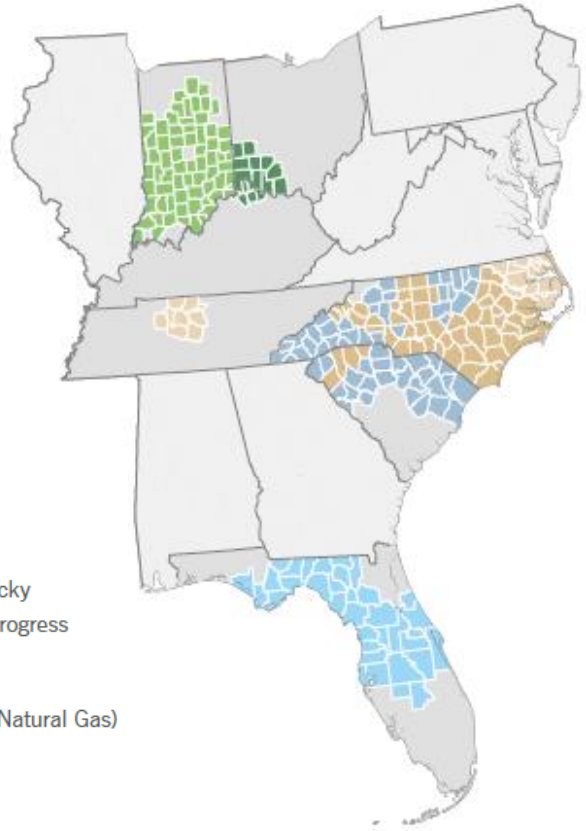
Duke Energy Overview

Regulated Electric Utilities

- Serve 7.8 million residential, commercial and industrial customers
- Serving in 6 states
- 51,144 MW generation
- Approximately 280,000 miles of distribution lines
- Approximately 31,000 miles of transmission lines

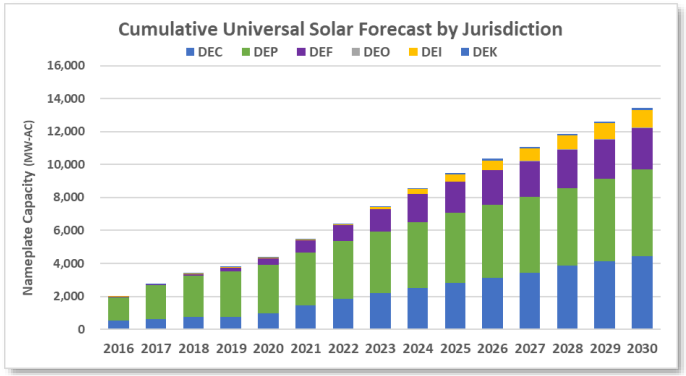
Commercial Renewables

- 2,282 MW generation
  (wind, solar, fuel cell & battery)
- Serving in 19 states

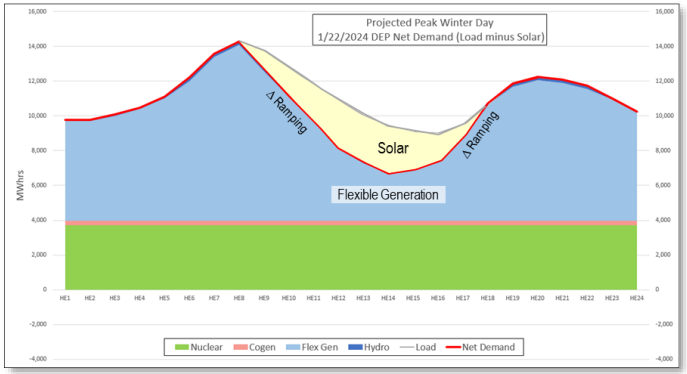


What are some of the challenges that we are addressing?

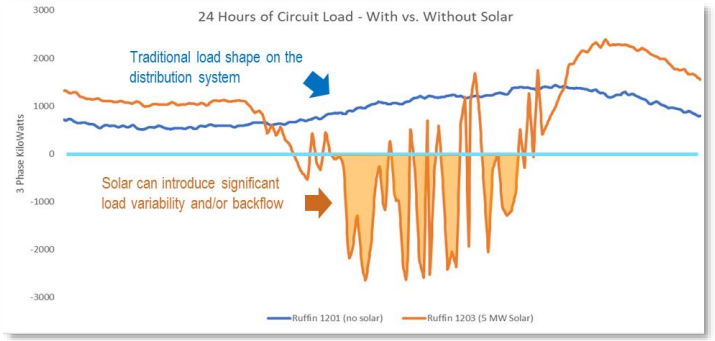
Rapid growth of renewables in our regions …



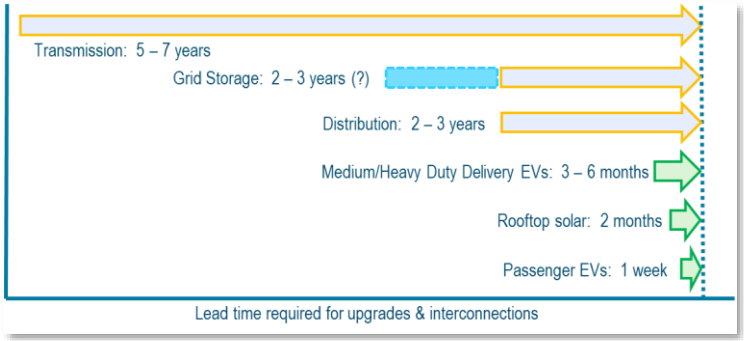
Increasing system resource flexibility needed …



Addressing dynamic loading on the grid …



Aligning planning timeframes with customer needs …

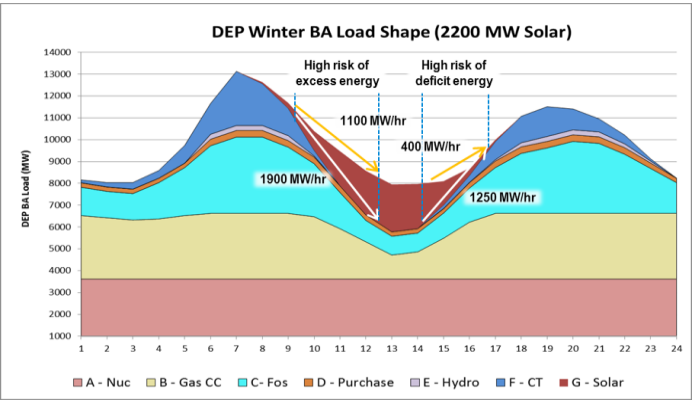


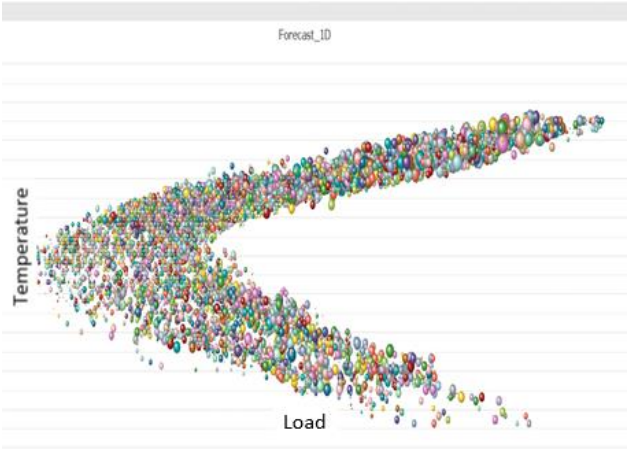
NERC Reserve Definitions – Traditionally Static Values

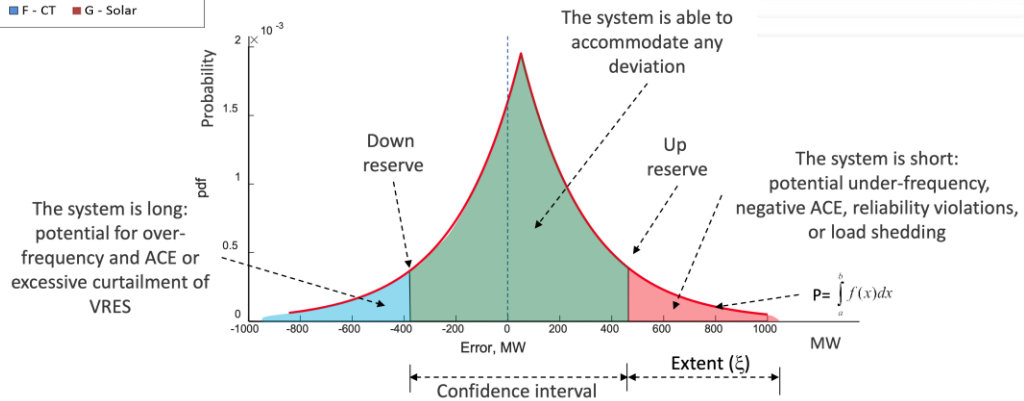
- Regulating Reserves
  - NERC Definition – “An amount of reserve responsive to Automatic Generation Control, which is sufficient to provide normal regulating margin.”
  - Duke Energy Implementation – Amount of energy a unit on AGC can contribute in the next 10 minutes in the up or down direction.
    - Exception- in MISO regulating reserves is a 5 minute product.
- Operating Reserves
  - NERC Definition- “Means that capability above firm system demand required to provide for regulation, load-forecasting error, equipment forced and scheduled outages and local area protection. Operating Reserve consists of Spinning Reserve and Nonspinning Reserve”
  - Duke Energy Implementation – Use a combination of Regulating, Contingency, and Balancing Reserves to maintain reliability required by carrying Operating Reserves.
- Balancing Reserves
  - No NERC Definition but is a term used throughout the industry as well as in Cost Production Models
  - Duke Energy Implementation – Generally a Day-Ahead product to cover some amount of load forecast error, solar forecast error as well as the loss of our single largest contingency in the up direction.
- Contingency Reserves
  - Defined by Reserve Sharing Group to cover some multiple of the Reserve Sharing Group’s Largest Single Contingency

Dynamic Reserves - Risk Quantification

- Estimate the risk (at a given period of time) based on statistical distribution of deviations (i.e. forecast errors):

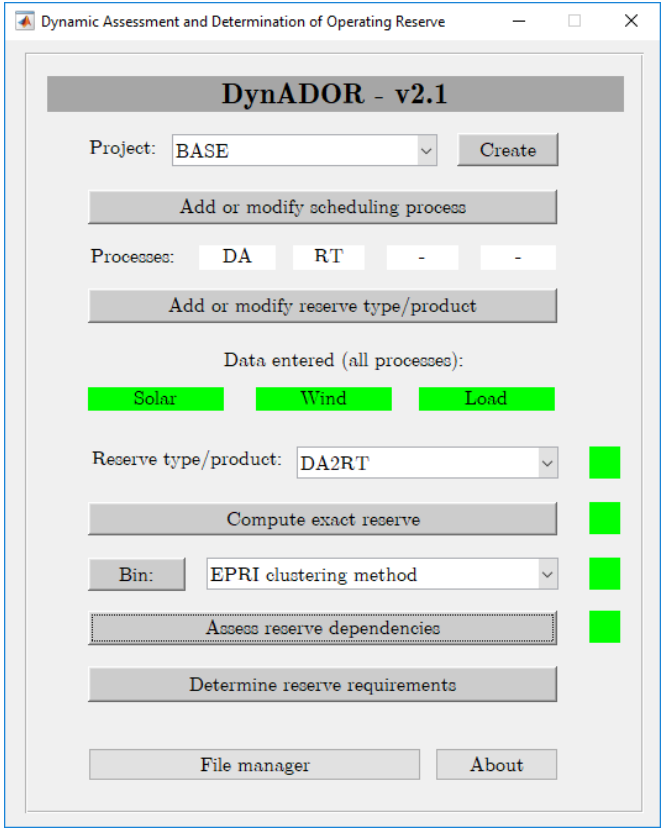






Dynamic Deterministic Reserves - EPRI's DynADOR Tool

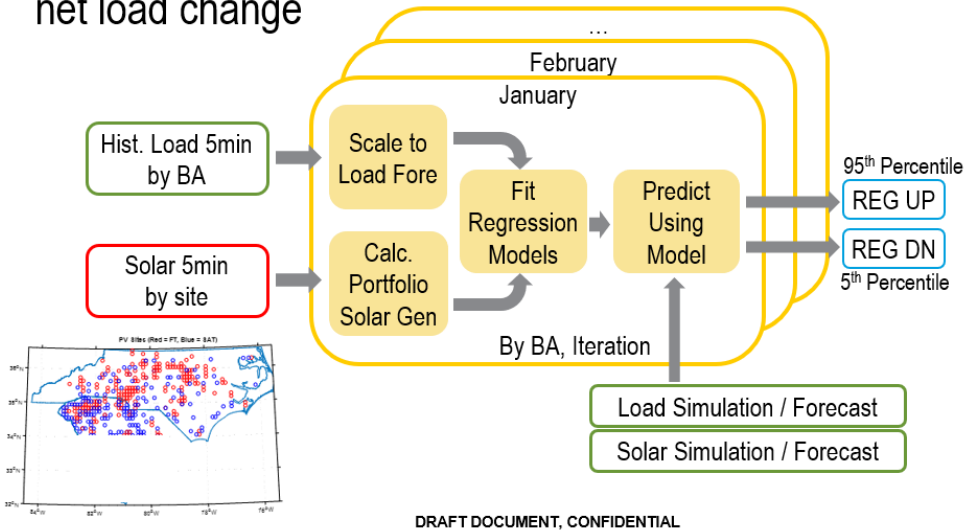
- Dynamic Assessment and Determination of Operating Reserve (DynADOR)
- Application of EPRI's **research methods** by development of software tool to determine "smart" reserve requirements
- Can be used in **operations or in studies**:
  - Day-ahead, month-ahead, real-time, input into long-term renewable integration study
- Applicable to different **balancing areas** types:
  - ISO/RTO, utility BA, International TSO, isolated system vs. large area
- Validation of results by means of detailed simulation studies



Example: Calculating Dynamic Regulating Reserve Requirements

Ancillary Requirement Calculation Workflow

- Regulating Reserves (10 minute product)
  - Quantile regression model predicts 5th & 95th percentiles of 10-min net load change



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DOE's OPTSUN Partners

SOLAR ENERGY TECHNOLOGIES OFFICE
U.S. Department Of Energy

Project Lead

EPRI ELECTRIC POWER RESEARCH INSTITUTE

Project Partners

UL

VT

POLARIS
SYSTEMS OPTIMIZATION

Utility Partners

DUKE ENERGY

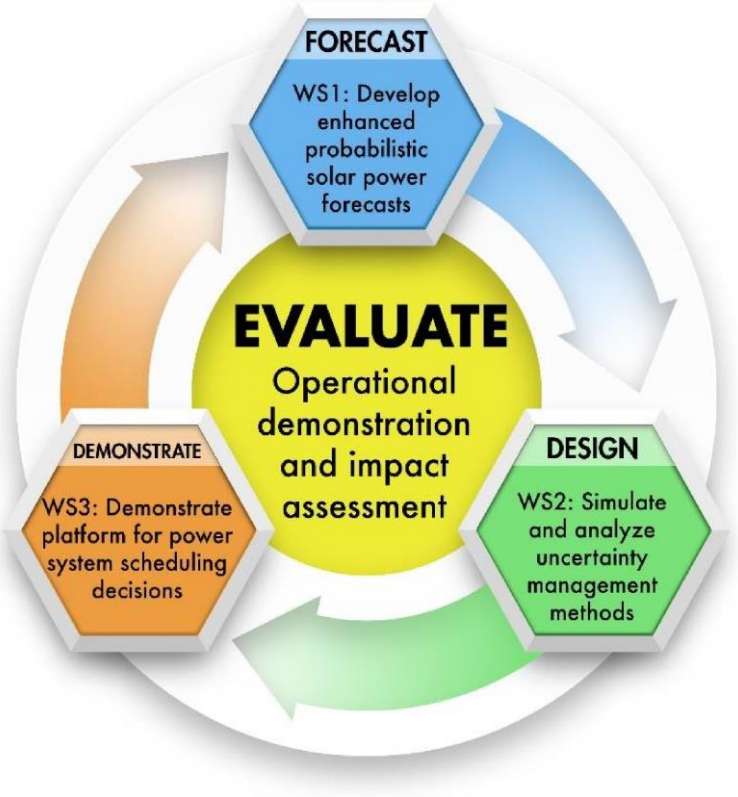
SOUTHERN COMPANY

Hawaiian Electric

DOE's OPTSUN (Operational Probabilistic Tools for Solar Uncertainty)

Three Interconnected Workstreams:

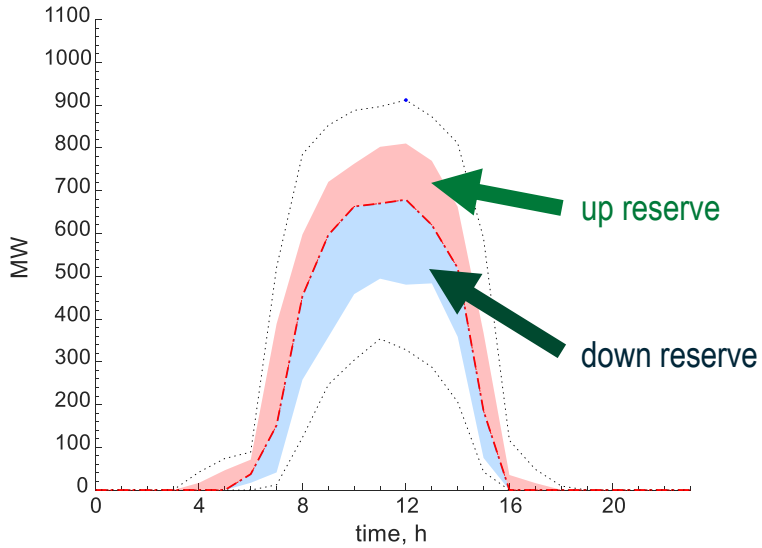
- **Forecast:** develop and deliver probabilistic forecasts with targeted improvements for utility-scale and behind-the-meter (BTM) solar
- **Design:** identify advanced methods for managing uncertainty based on results from advanced scheduling tools
- **Demonstrate:** develop and demonstrate a scheduling management platform (SMP) to integrate probabilistic forecasts and scheduling decisions in a modular and customizable manner



Forecast: Probabilistic Forecasts in Operations

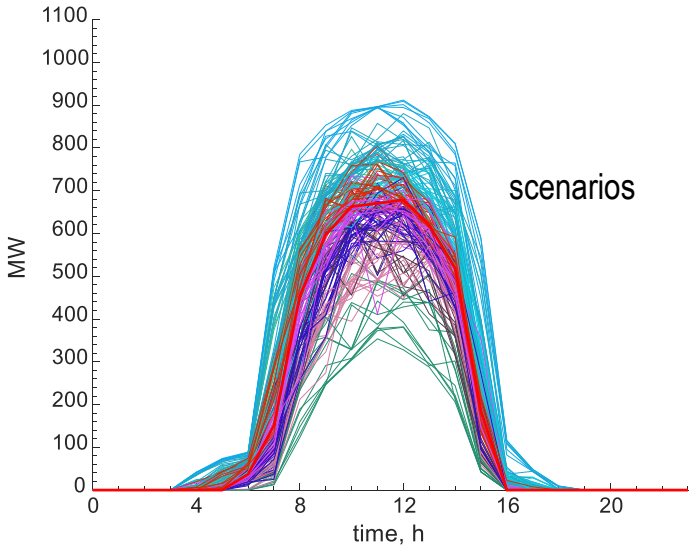
Use #1: Directly use to set reserves

- Set operating reserves based on probabilistic forecasts – different methods can be used

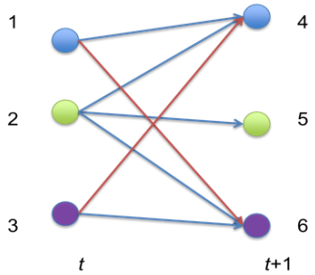


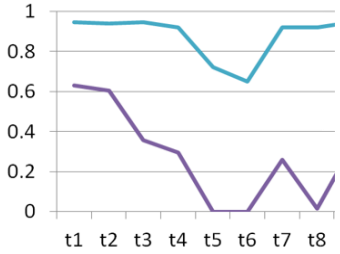
Use #2: Scenario Generation for UC or reserves

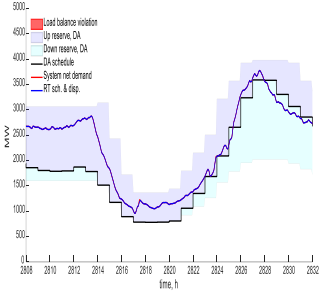
- Transform probabilistic info into scenarios, which can be used in a UC model to allow for stochastic UC



Design: Using Advanced Methods for Operating Systems With Uncertainty



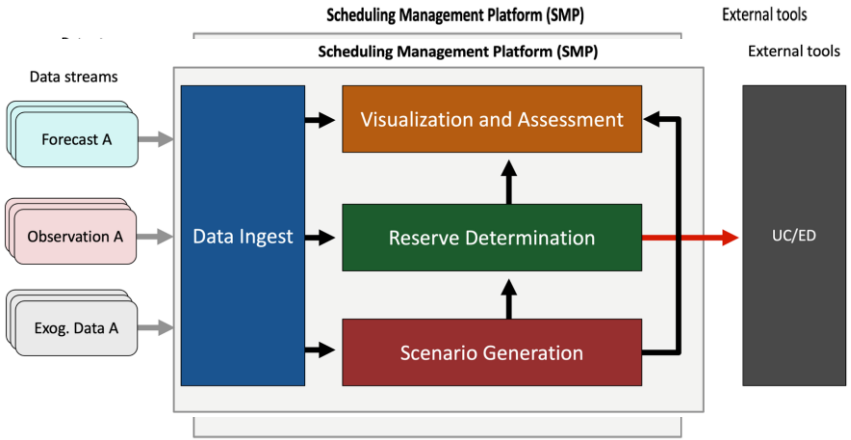


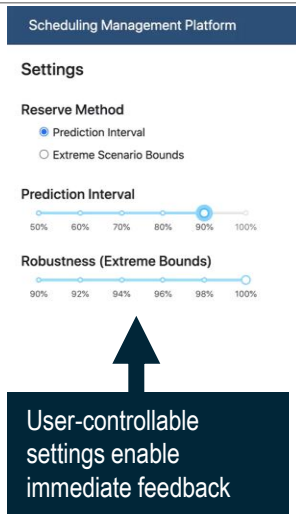


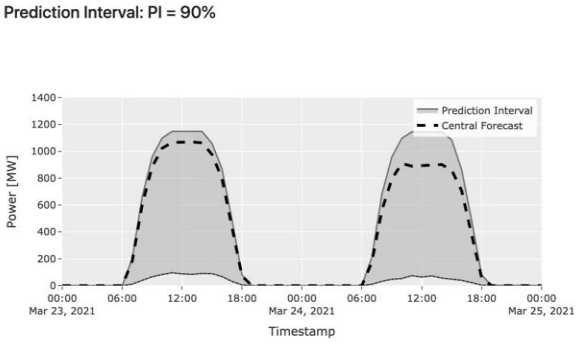
	Stochastic UC	Interval UC	Robust UC	Dynamic Reserves
Uncertainty Model	Scenarios	Inter-temporal rates	Uncertainty range	Requirements
Objective	min E{cost}	Minimize cost to meet central forecast	min{max{min *f*}}	Minimize operating cost to meet forecast
Security	Depends on the scenarios	Inter-temporal ranges	Uncertainty Budget	Confidence interval
Scalability	Low	High	Variable (high)	High

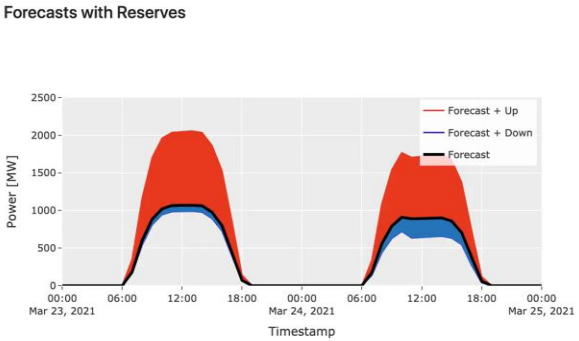
Can we use other methods to deal with uncertainty/variability?

Demonstrate: 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 project

Discussion Points and Future Steps

Questions:

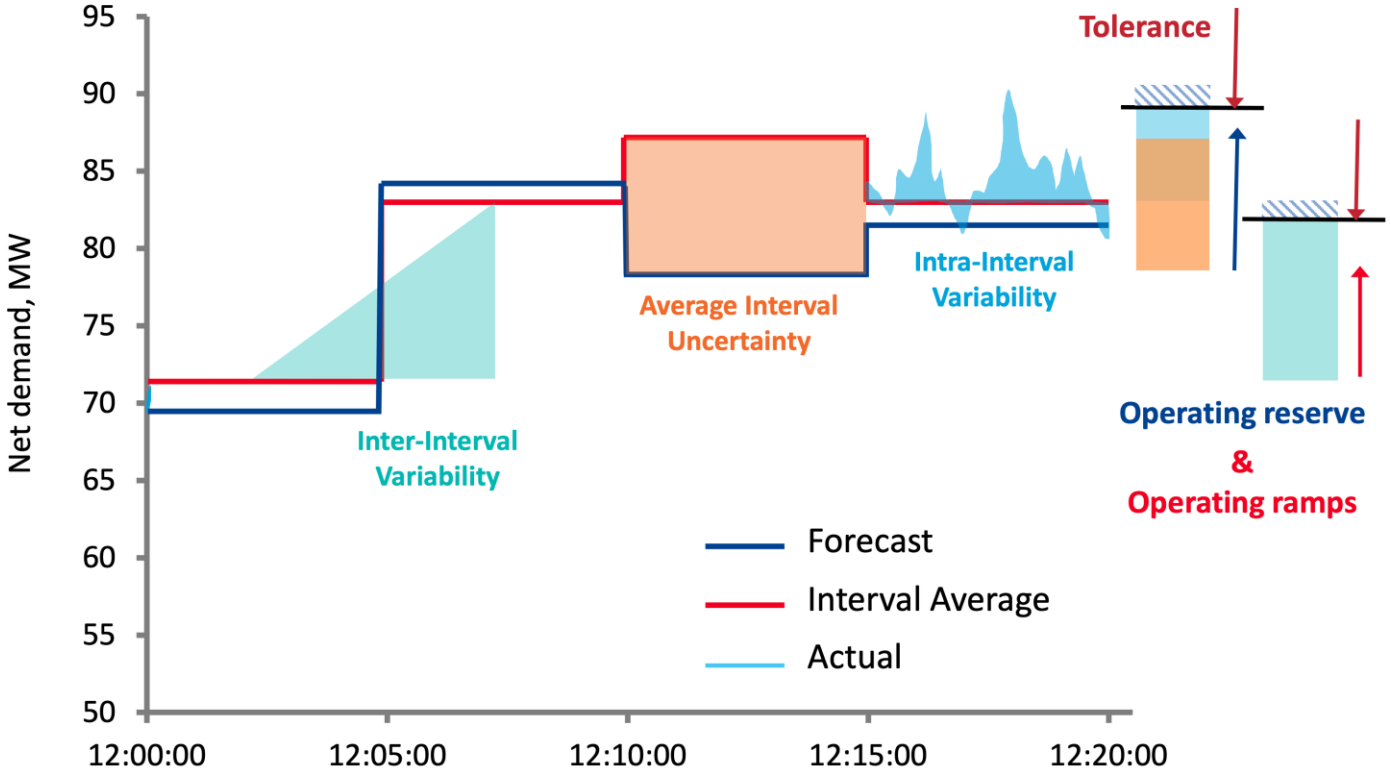
- What are the Reserve Products Needed?
- What are the Integration Best Practices for Operations and Planning?
- Reserves at what Time-Scale (10m, 1h, 4h, 1d)?
- Do the BA reserve requirements hold at scale VER (5%, 10%, 50%, 100%)?
  - Do they hold at Interconnection Scale?
- Calculate Reserves using Future Forecasts or Historical Performance?

Challenges:

- Aligning Reserve Product Definitions
- Developing and Implementing Models Representative of Real-Time Operations
- Additional Complexity (Accuracy) vs Computational Times & Usefulness
- Creating Reserve Methods that Useable and Digestible in Operations


DUKE
ENERGY®

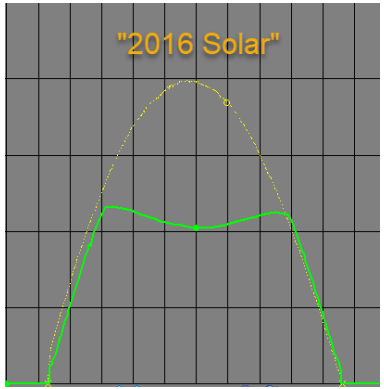
Central Reserve Needs

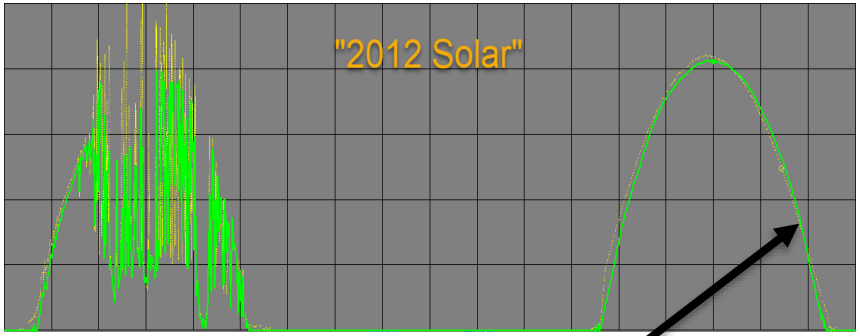


"An Enhanced Dynamic Reserve Method for Balancing Areas: A Dynamic Reserve Method for Balancing Areas with High Levels of Variability and Uncertainty on Their System and Case Studies Showing the Performance of These Methods," Electric Power Research Institute (EPRI), Palo Alto, CA, Rep. No. 3002010941, Dec. 2017.

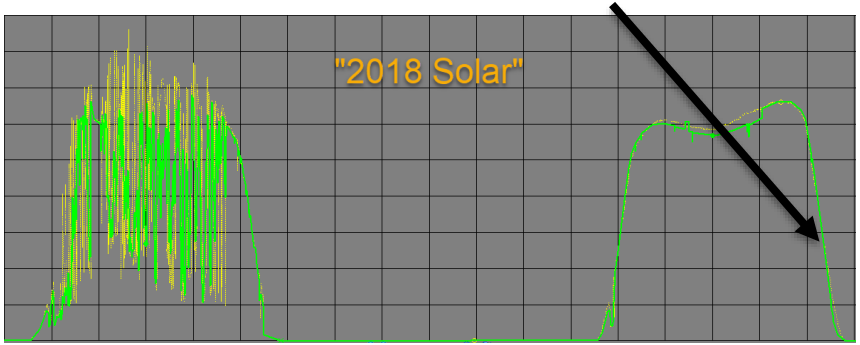
Challenges Forecasting Ancillary Model Inputs

- Any model is only as good as its inputs
- Clear Sky solar ramps increased by more than 50% in just 6 years.
- PV
  - Overpaneling
  - Fixed vs Tilt
  - Integrated Storage
- Wind
- Storage
- EV Charging
- Demand Response
- EE
- Covid-19, Climate Change & Extreme Weather





> 50% increase in Clear Sky ramps



ISOP Vision

The Integrated System & Operations Planning (ISOP) vision is a planning framework* that optimizes capacity and energy resource investments (MW/MWh) across Generation, Transmission, Distribution and Customer Solutions. The framework will address:

- **Operationally feasible plans** while accommodating rapid renewable growth
- **Enhanced modeling and analytics** to value new technologies such as energy storage, electric vehicles, intelligent grid controls and customer programs (non-traditional solutions for T&D)
- Ability to evaluate different asset portfolios across a **broader range of potential future scenarios**

* Initial ISOP Focus: Carolinas Region