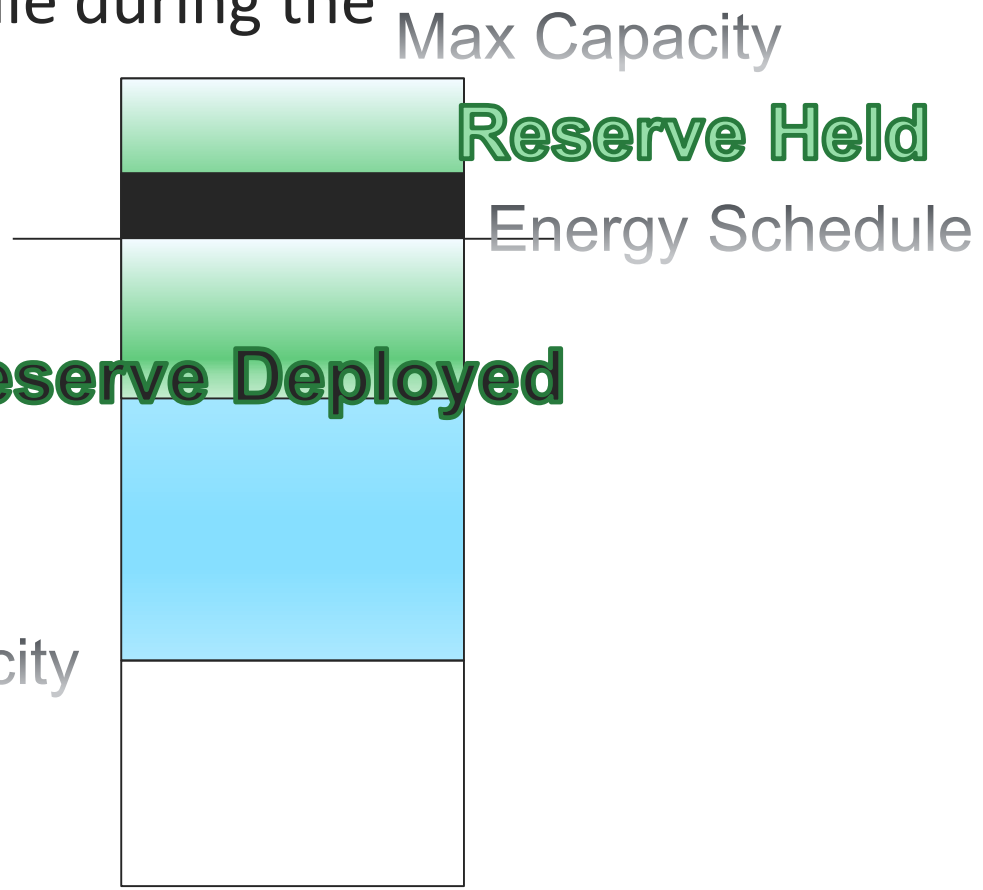
Some thoughts on operating reserve

Erik Ela,
DOE Electricity Advisory Council
Washington, DC
June 19, 2019

Operating Reserve Objectives

- Operating Reserve: Active power, energy, or ramp capacity that is above or below the average expected schedule of a supply resource, where that capacity is capable of being used to respond to system conditions that are different from the conditions that determined the average expected energy schedule during the operational time frame.
  - **Flexibility in operational timeframes**
- Used for multitude of reasons:
  - Maintain frequency at nominal level (60 Hz in U.S.)
  - Reduce Area Control Error (ACE) to zero
  - Assist neighboring balancing authority
  - Reduce over flow of transmission system
  - Reduce production costs
  - Avoid infeasibilities/price spikes



Reserve for Cost Reduction

	Variable Fuel Cost	Min Gen	Capacity	Started in RT?
G1	20$/MWh	25 MW	100 MW	No
G2	30$/MWh	25 MW	100 MW	No
G3	80$/MWh	5 MW	100 MW	Yes

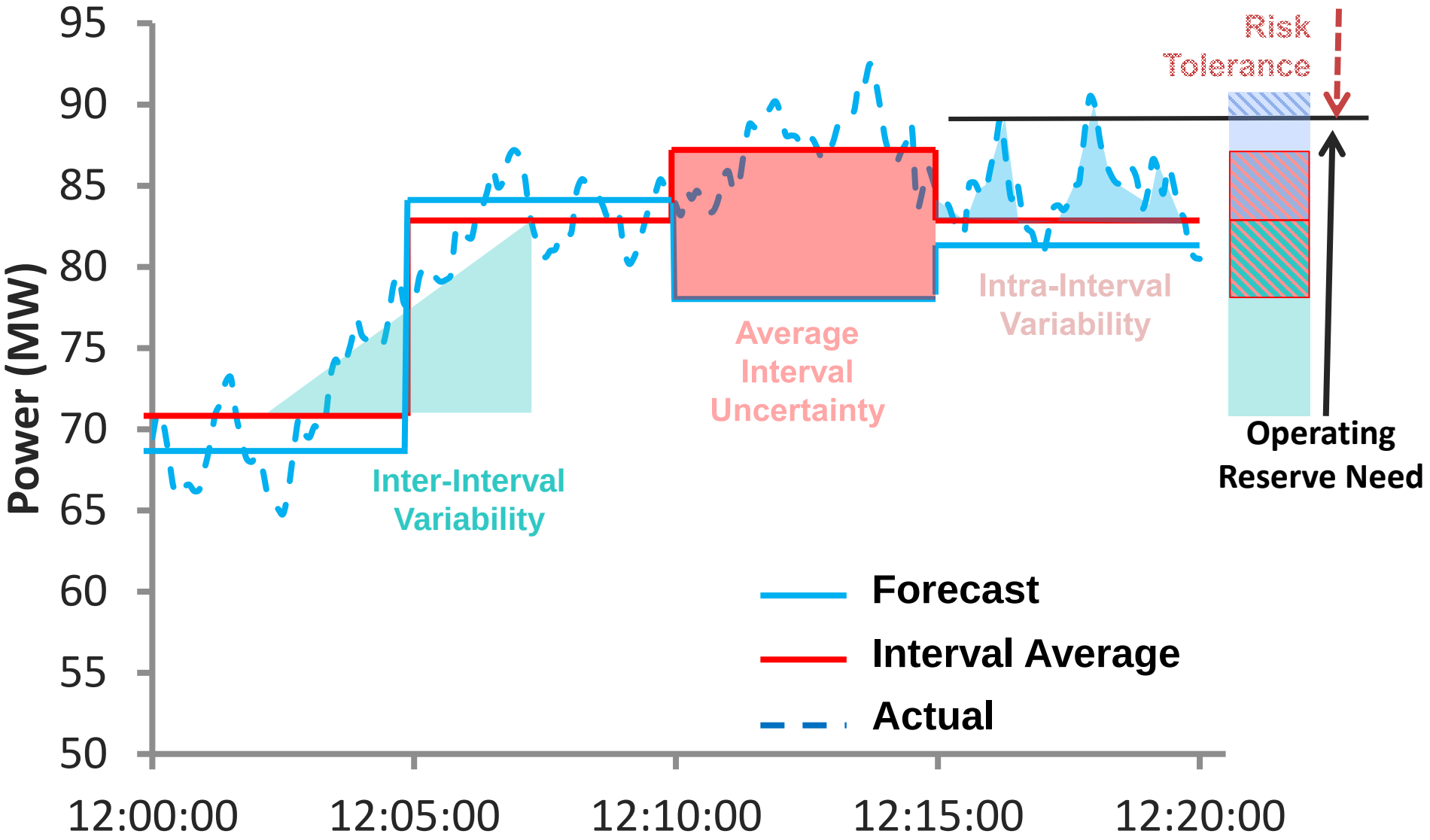
Load / Spin Reserve	DA	RT
Scenario 1	100 / 0	125 / 0

Scenario 1	DA	RT
G1	100	100
G2	0	0
G3	0	25
Cost ($)	2,000	4,000

Scenario 2	I1	I2
G1 (Sched/Spin)	75/25	100
G2 (Sched/Spin)	25/0	25
G3 (Sched/Spin)	0/0	0
Cost ($)	2,250	2,750

Not only does smart reserve requirements improve reliability, it also can reduce costs

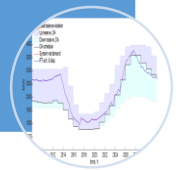
Three Central Reserve Needs



Mechanisms to Ensure Flexibility Provided Reliably and Cost-Effectively

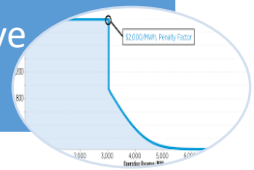
Address uncertainty through increased reserve

Uncertainty reserve products



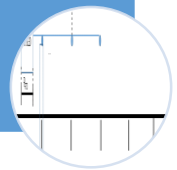
Value reserve above minimum requirements

Operating Reserve Demand Curve



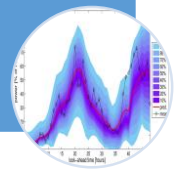
Price opportunity costs of ramp

Multi-interval settlement



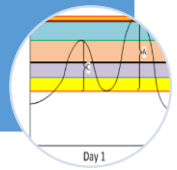
Represent uncertainty explicitly

Stochastic multi-scenario market scheduling



Make sure flexibility is built

Forward Flexible Capacity Attribute Procurement



Let demand provide flexibility inherently

Real-time demand pricing

Flatten the curve with correct incentives

Energy Storage

Reduce uncertainty directly

Enhanced Forecasting

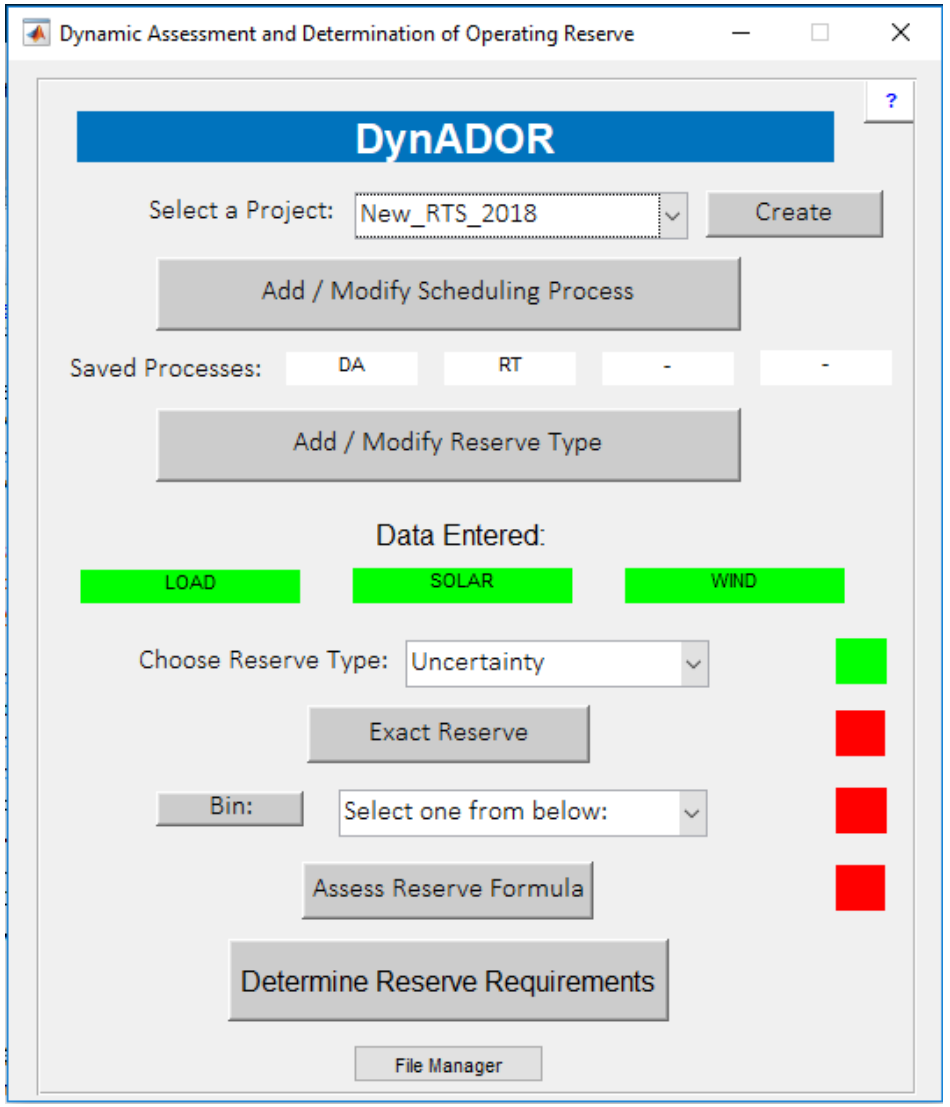
Dynamic Assessment and Determination of Operating Reserve (DynADOR)

- EPRI method to **forecast** the operating reserve, particularly for systems with large levels of wind and solar
  - Just like forecasting load or renewable production

- Step 1: **Define** reserve product and scheduling processes
- Step 2: **Study** historical reserve needs
- Step 3: **Train** model with explanatory variables
- Step 4: **Forecast** future reserve requirement needs with exceedance confidence

- Method can work for different horizons (e.g., regulation or ramp), and different utility region characteristics (e.g., island, large interconnected)

- Conducted multiple simulation studies seeing **simultaneous reductions in cost and increases in reliability metrics.**



Together...Shaping the Future of Electricity