Education: Uncertainties in PJM's Resource Adequacy Construct

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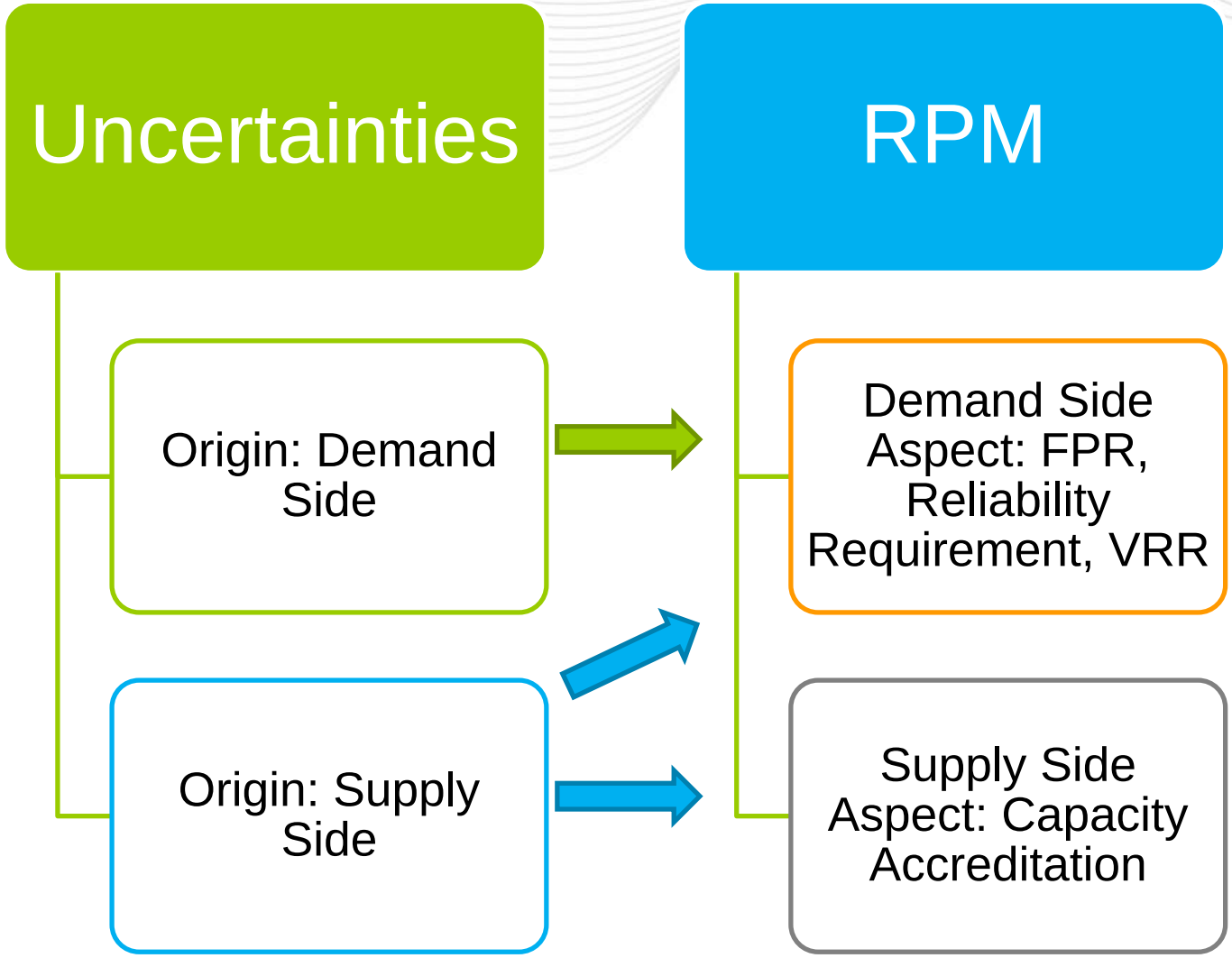
Resource Adequacy Uncertainties and RPM

- The loss of load risk for the system (and its expected transmission configuration) is driven by uncertainties that have their **origin** either on the **supply-side** or the **demand-side**
- The uncertainties (either supply-side or demand-side) can be accounted for in two aspects of the RPM construct
  - Forecast Pool Requirement, Reliability Requirement, Variable Resource Requirement curve (**demand-side aspect**)
  - Capacity Accreditation (**supply-side aspect**)

Uncertainties: Origins and how they are addressed in RPM



RA Studies/Calculations that support the RPM Construct

- Reserve Requirement Study (RRS)
- Capacity Emergency Transfer Objective (CETO)
  - Calculation of LDA Reliability Requirement
  - Calculation of Transmission Capability Needs
- Capacity Emergency Transfer Limit (CETL)
- Effective Load Carrying Capability (ELCC)
- Outage Metrics
  - Equivalent Demand Forced Outage Rate (EFORd)
  - Equivalent Planned Outage Factor (EPOF)
  - Equivalent Maintenance Outage Factor (EMOF)

Uncertainties – Overview

Uncertainty	Origin	In RPM, reflected in:	Season
Load Forecast	Demand	Demand	All
Random Forced Outages of Unlimited Thermal Resources	Supply	Supply	All
Planned Outages of Unlimited Thermal Resources	Supply	Demand	All (except Summer)
Maintenance Outages of Unlimited Thermal Resources	Supply	Demand	All
Ambient Derates of Unlimited Thermal Resources	Supply	Demand	Summer
Outages and limitations of ELCC Resources	Supply	Supply	All
Outages and Limitations of DR Resources	Supply	Supply (partially)	All
Cold Weather-Related Forced Outages of Unlimited Thermal Resources	Supply	Demand	Winter
Emergency Imports	NA	Demand	All

Load Forecast

Origin: Demand. **Reflected in RPM**: Demand-side

Status Quo Modeling:

PJM Load Forecast only models weather uncertainty (but not uncertainty around the other input variables) using weather data in period 1994-2020

RRS and CETO: use PJM Load Forecast but PRISM is restricted to use normal distributions built with historical load data. In PRISM, only the summer peak week's normal distribution approximately matches PJM Load Forecast uncertainty. The rest of the weeks may or may not match the PJM Load Forecast uncertainty.

ELCC: based on PJM Load Forecast uncertainty

CETL: zone under study modeled at 90/10 load; other zones at 50/50 load

Random Forced Outages of Unlimited Thermal Resources

Origin: Supply. **Reflected in RPM**: Supply-side

Status Quo Modeling:

Accreditation: based on most recent 1-year EFORd calculated using GADS data

RRS, CETO, ELCC: based on most recent 5-year EFORd calculated using GADS data

CETL: based on most recent 5-year EFORd calculated using GADS data

Planned Outages of Unlimited Thermal Resources

Origin: Supply. **Reflected in RPM**: Demand-side

Status Quo Modeling:

Impact on RTO reliability requirement is currently 0 MW UCAP; impact on the reliability requirement of modeled LDAs that have risk spread-out across seasons is greater than 0 MW

Accreditation: not reflected

RRS, CETO, ELCC: based on most recent 5-year Equivalent Planned Outage Factor (EPOF) for each unlimited thermal unit calculated using GADS data. The planned outage schedule is then derived by using a heuristic that levelizes weekly thermal reserves throughout the year. This schedule generally yields no planned outages during the summer peak period; most of the planned outages are scheduled during the shoulder seasons

CETL: 0 MW of planned outages

Maintenance Outages of Unlimited Thermal Resources

Origin: Supply. **Reflected in RPM**: Demand-side

Status Quo Modeling:

Impact on RTO reliability requirement is currently ~1,500 MW UCAP. Also, there are impacts on reliability requirement of modeled LDAs

Accreditation: not reflected

RRS, CETO, ELCC: based on most recent 5-year Equivalent Maintenance Outage Factor (EMOF) calculated using GADS data. A quarter (1/4) of the EMOF is added to the EFORd to create the EEFORd of each unit; the remainder (3/4) is added to the EPOF

CETL: 0 MW of maintenance outages

Ambient Derates of Unlimited Thermal Resources

Origin: Supply. **Reflected in RPM**: Demand-side

Status Quo Modeling:

Impact on RTO reliability requirement is currently between 2,000 and 2,500 MW UCAP

Accreditation: not reflected. Testing (and ICAP values) are based on 50/50 weather conditions. Ambient derates occur during weather conditions more extreme than 50/50 weather.

CETO: not reflected

RRS, ELCC: evaluation of summer test data 5 years ago established that around 2,500 MW of ICAP are affected by ambient derates.

CETL: 0 MW of ambient derates

Outages and Limitations of ELCC Resources

Origin: Supply. **Reflected in RPM**: Supply-side

Status Quo Modeling:

Accreditation: modeled uncertainty is reflected in accreditation via Average Total ELCC (includes EFORd calculation for some ELCC classes)

CETO: differs by resource type but in general all outages and limitations are not reflected (for reliability requirement calculation purposes, this is adequate)

RRS: not included because accreditation process is intended to reflect all the uncertainty

CETL: modeled at CIR value

Outages and Limitations of DR Resources

Origin: Supply. **Reflected in RPM**: Supply-side (partially)

Status Quo Modeling:

Accreditation: no impact; 1 MW ICAP of DR is assumed to be worth around 1.08 MW UCAP (if FPR is equal to 1.08)

CETO: DR outages and limitations are not reflected (for reliability requirement calculation purposes, this is adequate)

RRS: not reflected; this is adequate because limitations should be on the accreditation side

ELCC: dispatched in model reflecting performance window limitations

CETL: modeled at value included in PJM Load Forecast (reduction of load)

Cold Weather-related Forced Outages of Unlimited Thermal Resources

Origin: Supply. **Reflected in RPM**: Demand-side

Status Quo Modeling:

For the RTO, modeling does not increase the reliability requirement; for some LDAs with winter risk, it increases the reliability requirement

Accreditation: mostly not reflected (the 1-year EFORd may reflect some of these outages if they occurred in the 1-year period; however, the correlation with weather is not captured)

RRS, CETO, ELCC: based on ~11 years of actual aggregate RTO-wide forced outage rates during winter peak weeks (this modeling technique basically captures random and cold weather-related forced outages)

CETL: Considers gas pipeline contingencies

Emergency Imports

Origin: Not applicable. **Reflected in RPM**: Demand-side

Status Quo Modeling:

RRS: decreases the FPR by around 1.33 percentage points (~2,000 MW UCAP). An approximate model that assesses peak load coincidence between PJM and its neighbors is used to determine the above value. Also, the approximate model uses the Capacity Benefit Margin (equal to 3,500 MW) as the maximum amount of emergency imports that PJM can receive at any given hour.

CETL: Not considered

Future Discussions

- Should some supply-side uncertainties currently reflected on the demand-side of the RPM construct be addressed on the supply-side of the RPM construct?
- Should the status quo modeling/quantification of these uncertainties be modified?
- What uncertainties are not listed in this presentation? Can those uncertainties be reasonably quantified?

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