PJM CETO/CETL & Load Deliverability

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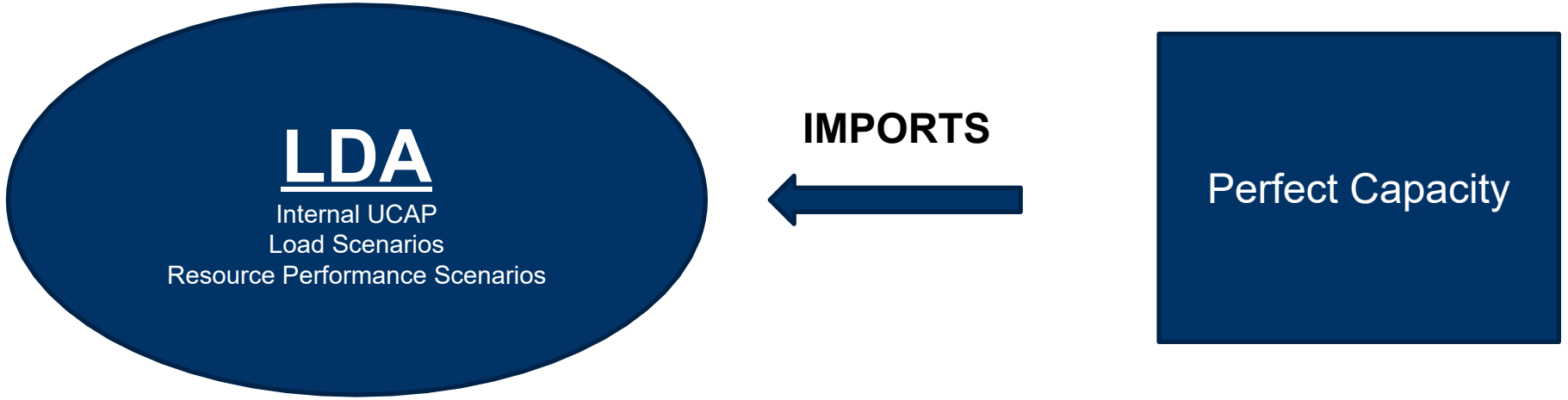
Capacity Emergency Transfer Objective (CETO)

- Amount of imports needed by an LDA to meet the LDA's reliability criteria
  - Calculated probabilistically (multiple load scenarios and resource performance scenarios are examined)
  - Current reliability criteria for LDAs is: 40% of the RTO normalized EUE at the "1 in 10" criteria
- The CETO is one of the key inputs to the calculation of the Reliability Requirement of an LDA, which is then used in RPM to derive the LDA's demand curve (if the LDA is explicitly modeled in RPM)
  - Reliability Requirement = CETO + LDA's Internal UCAP



Capacity Emergency Transfer Objective (CETO)

- The CETO values:
  - Can be negative (if the LDA has a large amount of internal UCAP relative to load), zero, or positive
  - In general, removing internal UCAP from an LDA, increases the CETO
  - The CETO value depends on the loss of load risk patterns of the LDA given the load scenarios and the resource performance scenarios
- Reliability Must Run (RMR) units
  - Included in “machine list” used in case.
  - Therefore, they are accounted for as part of the LDA’s Internal UCAP

How does an LDA's CETO change if we remove a resource from the LDA?

- In general, the CETO of an LDA will increase if a unit is removed from the LDA
  - In an extreme case, the CETO may not change if a unit is removed from an LDA. This situation can occur if a unit always outputs 0 MW during the risk hours in an LDA
- What is the magnitude of the CETO increase if a unit is removed from the LDA?
  - In general, the CETO will increase by the unit's expected output during the LDAs' hours of risk
  - For example, if a unit is always producing X MW during the LDA risk hours, then the CETO will increase by X MW if the unit is removed
  - However, if a unit is not always providing X MW during the LDA risk hours, then the CETO will increase by less than X MW if the unit is removed

How does an LDA's Reliability Requirement change if we remove a resource from the LDA?

- The Reliability Requirement (RR) is defined as:
  - RR = CETO + Internal UCAP
- When we remove a unit from an LDA we know that the CETO will likely increase. Also, removing a unit decreases the Internal UCAP of the LDA. Therefore,
  - New RR = New CETO + New Internal UCAP
  - New RR = (CETO + CETO Increase) + (Internal UCAP – Decrease in Internal UCAP)
  - New RR = (CETO + Internal UCAP) + (Ceto Increase – Decrease in Internal UCAP)
  - New RR = RR + (CETO Increase – Decrease in Internal UCAP)
- The New RR effectively depends on the difference between the CETO increase and the Decrease in Internal UCAP.

How does an LDA's Reliability Requirement change if we remove a resource from the LDA?

- Consider an example ("No change to RR")
  - We remove a unit that on average produces 950 MW during the LDA's hours of risk (say, a 1000 MW ICAP nuclear resource in a mid-size to large-size LDA). This unit is accredited at 950 MW UCAP (the accreditation is performed from an RTO perspective)
  - The New RR is equal to:
    - New RR = RR + (CETO Increase – Decrease in Internal UCAP)
    - The CETO increase will be 950 MW
    - The Decrease in Internal UCAP will be 950 MW. Therefore,
    - New RR = RR + 950 – 950 = RR
    - The New RR will be equal to the original RR

How does an LDA's Reliability Requirement change if we remove a resource from the LDA?

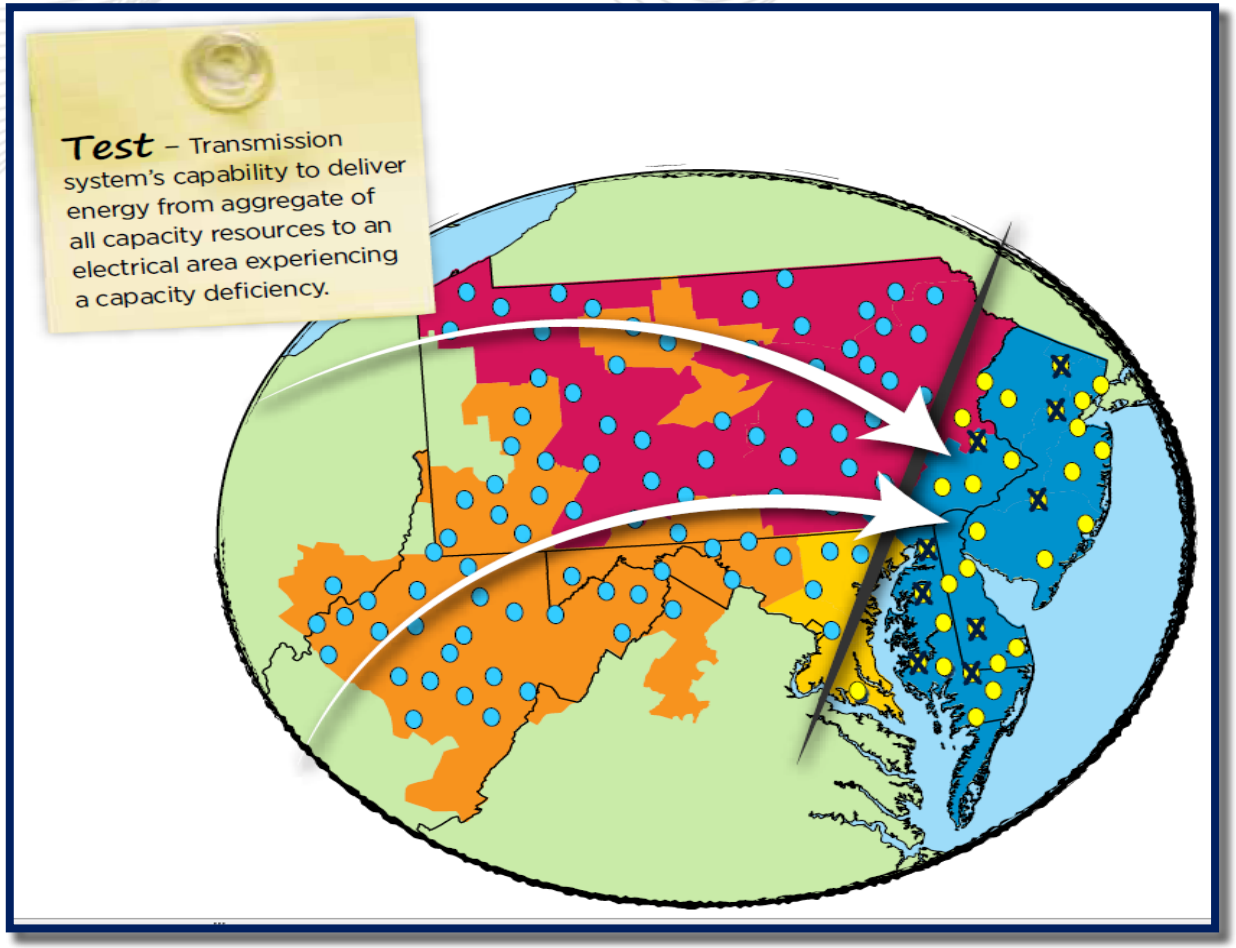
- Consider another example ("RR increases")
  - We remove a unit that always produces 100 MW during the LDA's hours of risk (say, a 100 MW ICAP 4-hr storage resource in an LDA with only summer risk that has short loss of load events). This unit is accredited at 59 MW UCAP (the accreditation is performed from an RTO perspective)
  - The New RR is equal to:
    - New RR = RR + (CETO Increase – Decrease in Internal UCAP)
    - The CETO increase will be 100 MW
    - The Decrease in Internal UCAP will be 59 MW. Therefore,
    - New RR = RR + 100 – 59 = RR + 41
    - The New RR will be greater than the original RR by 41 MW.

How does an LDA's Reliability Requirement change if we remove a resource from the LDA?

- Consider another example ("RR decreases")
  - We remove a unit that always produces 13 MW during the LDA's hours of risk (say, a 100 MW onshore wind resource in an LDA with only summer risk). This unit is accredited at 35 MW UCAP (the accreditation is performed from an RTO perspective)
  - The New RR is equal to:
    - New RR = RR + (CETO Increase – Decrease in Internal UCAP)
    - The CETO increase will be 13 MW
    - The Decrease in Internal UCAP will be 35 MW. Therefore,
    - New RR = RR + 13 – 35 = RR - 22
    - The New RR will be less than the original RR by 22 MW.

Load Deliverability Test

- The load deliverability test ensures sufficient transmission capability exists on the PJM system to supply emergency power from the aggregate of PJM generation to LDAs experiencing capacity emergency and high load conditions

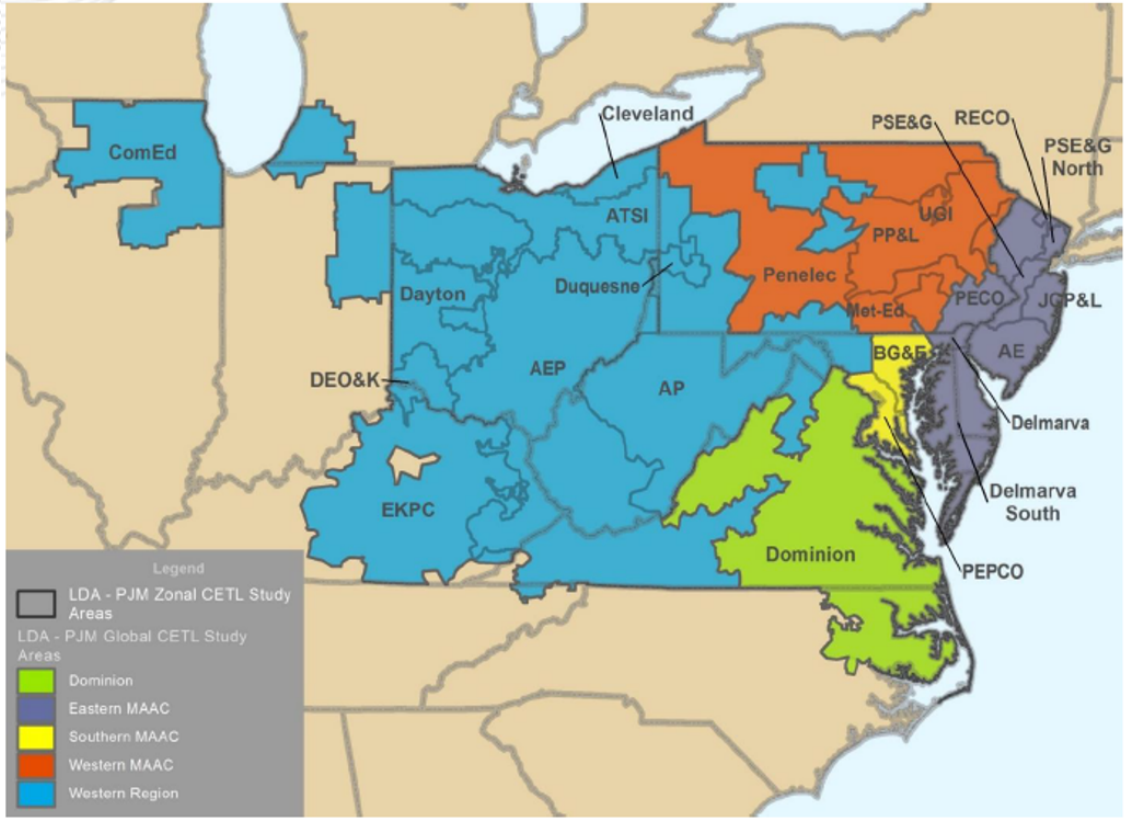


Applications of Load Deliverability Test

- Annually as part of the RTEP (summer and winter)
- Annually prior the RPM Base Residual Auction
- As needed for Interconnection Requests
- As needed for Incremental Capacity Transfer Rights (ICTRs)
- As needed for Generation Deactivations (pass / fail only)

CETO/CETL & Load Deliverability Areas

- Capacity Emergency Transfer Objective (CETO): Amount of import capability under peak load emergency conditions into a defined area to maintain the LDA reliability criteria
  - Hourly load scenarios covering wide range of load levels according to PJM Load Forecast
  - PJM is divided into 27 “electrically cohesive” Load Deliverability Areas (LDAs). Each LDA is evaluated separately.
  - The LDA reliability criteria (40% of the RTO normalized EUE at the “1 in 10” criteria) refers to the expected amount of MWh an LDA sheds due to insufficient import capability only.
- Capacity Emergency Transfer Limit (CETL) measured against CETO to determine system ability to import capacity into and LDA under peak load emergency conditions



CETO/CETL Study Results

- If CETL > CETO, the LDA passes the test; import limits can cover the need.

- If CETL<CETO, the LDA fails the test, imports cannot cover the need.

- Transmission upgrades can be ordered by the board
- If CETL < 1.15*CETO, then LDA is modeled separately in RPM auction and may bind (clear at a price higher than the RTO-wide market clearing price).

CETL Case Development

1. Case Development

- Start with the applicable RTEP base case and set PJM load to coincident peak levels
- Each LDA studied independently at higher of 90/10 load level minus demand response or 50/50 load
- Two separate power flow cases created for each LDA at CETO level. Rest of PJM is assumed to be operating normally and generation is scaled up uniformly to supply the LDA's CETO
  - Mean Dispatch Case: models the average value of each generator's output for the LDA under study from over 10,000 unique dispatches at the CETO
  - Discrete Outage Case: models the most likely discrete generator outage pattern within the LDA at the CETO

2. Thermal Analysis

- Iteratively find the thermal import limit into the LDA separately for both the mean and discrete outage dispatch cases, i.e. start with the CETO case and gradually increase power imported into the LDA
- PJM uses the TARA program to simulate power transfer into the LDA while simultaneously performing a security constrained redispatch of PJM generation outside the LDA
- Generation inside the LDA is decreased uniformly (MW and MVAR capability) until the import limit(s) is identified

CETL Voltage Analysis

3. Voltage Analysis

- Use TARA program is used to create the CETL power flow case
- Next, a N-1 contingency screening is performed for each LDA at the thermal import limit to determine whether there are any relevant voltage magnitude or voltage drop import limits
  - If there are no voltage issues at the thermal import limit, then the lower of the thermal import limits identified using the mean and discrete outage dispatch cases defines the CETL
  - If there are voltage issues at the thermal import limit, then PV analysis is used to determine the voltage import limit and it defines the CETL

CETL - Treatment for RMR resource(s)

- RMR resource(s) are included in the CETL calculation
  - RMR unit is expected to produce MWs under emergency conditions
  - RMR is a stop gap transmission solution
- Annually as part of RTEP, the case's topology and available resource will be updated to reflect newly in-service projects.
  - Once the required upgrades are in service, RMR resource(s) will be removed and upgrades included in CETL analysis.
- What happens when an RMR resource is removed from CETL without upgrades?
  - CETL >> CETO – Don't expect CETL to change
  - CETO ~= CETL (If CETL>CETO) – Need detailed analysis to understand impacts
  - CETO>CETL – Case may not solve

Deactivation Analysis - CETL Pass / Fail

- Meant to act as screening only to check if CETL would be lower than CETO
- Does not go into the iterative nature to determine actual CETL of a LDA.
- Run N-1 on the starting CETO case, if there are no violations, or the associated Outage Transmission Distribution Factor (OTDF) of a flowgate is lower than threshold (<2% for >=345 kV or <5% for < 345 kV), then CETL is at least equal or greater than CETO, and it passes

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APPENDIX

Comparison

Item	Deactivation - Reliability Analysis	Load Deliverability
Granularity	Nodal Analysis	LDA Analysis
Load level	50/50 non-diversified	50/50 diversified, LDA at 90/10 non diversified
Analysis type	Thermal, Voltage	Thermal, Voltage
Case Step Up - Resources	Generator dispatch follows M14B methodologies (Block Dispatch)	With multiple Generator outages(mean, discrete) as pre-existing condition for LDA under study
Contingency Simulated	N-1, N-1-1	N-1 for the LDA under study

Version History

- 8/12/2024 – Original Posting
- 9/25/2024 – Updates to slides 11 and 15

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