



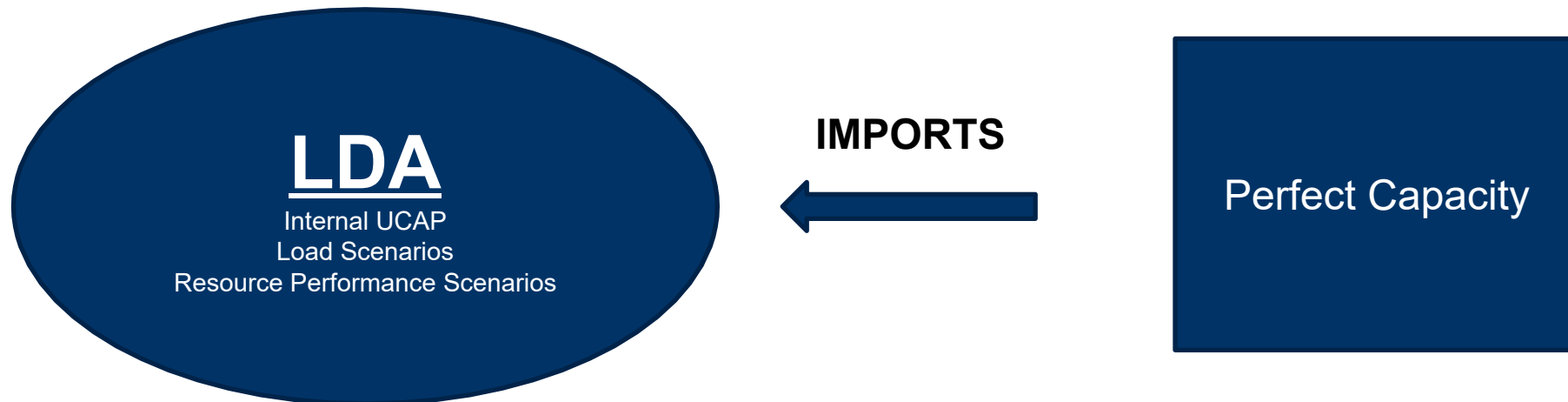
PJM CETO/CETL & Load Deliverability

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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 1 day in 25 years
- 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



- **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?

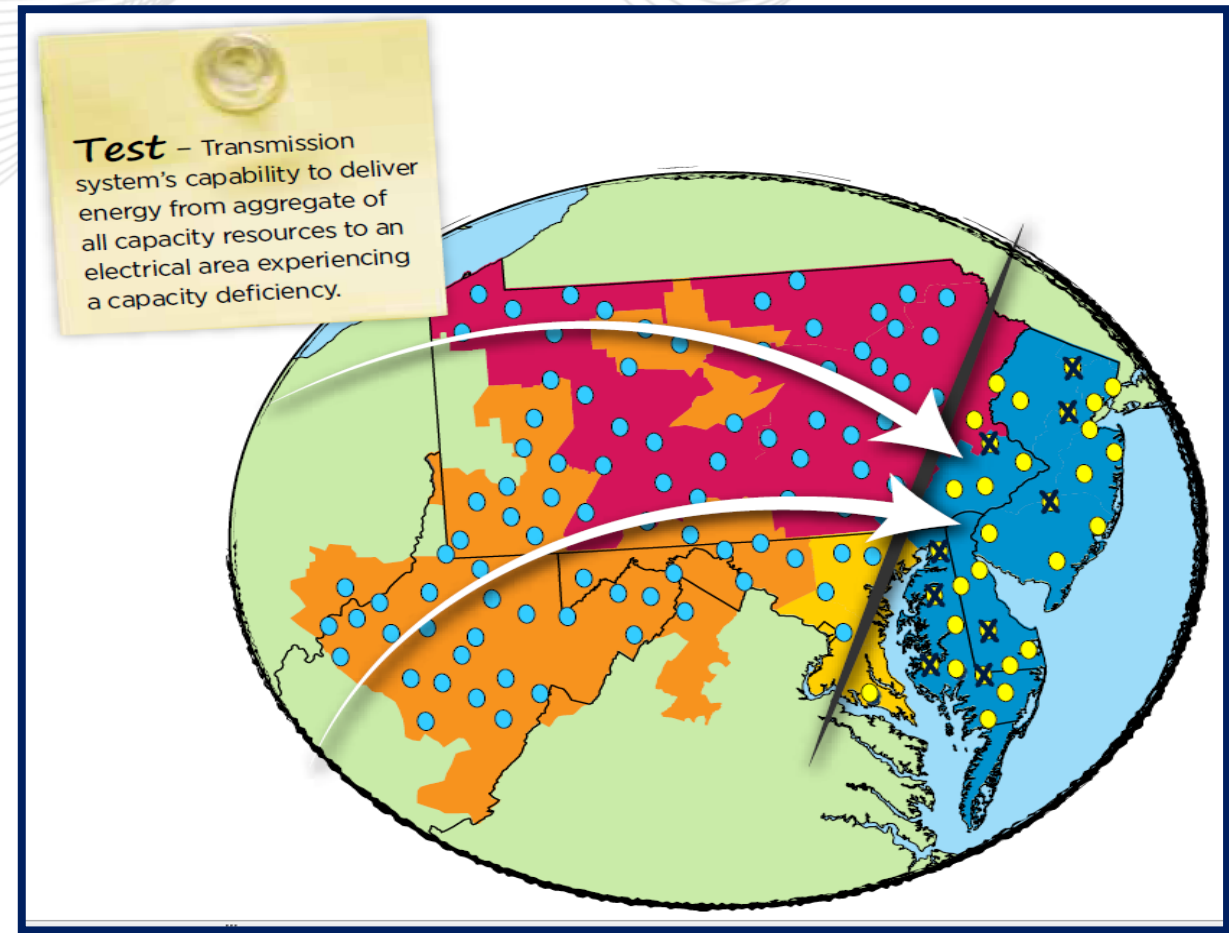
- In general, the CETO of an LDA will increase if a unit is removed from the LDA
 - In an extreme case, the CETO may not change if a unit is removed from an LDA. This situation can occur if a unit always outputs 0 MW during the risk hours in an LDA
- What is the magnitude of the CETO increase if a unit 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

- The Reliability Requirement (RR) is defined as:
 - $RR = CETO + \text{Internal UCAP}$
- 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,
 - $\text{New RR} = \text{New CETO} + \text{New Internal UCAP}$
 - $\text{New RR} = (\text{CETO} + \text{CETO Increase}) + (\text{Internal UCAP} - \text{Decrease in Internal UCAP})$
 - $\text{New RR} = (\text{CETO} + \text{Internal UCAP}) + (\text{Ceto Increase} - \text{Decrease in Internal UCAP})$
 - $\text{New RR} = \text{RR} + (\text{CETO Increase} - \text{Decrease in Internal UCAP})$
- The New RR effectively depends on the difference between the CETO increase and the Decrease in Internal UCAP.

- Consider an extreme example

- We remove a unit that always produces 0 MW during the LDA's hours of risk. This unit is accredited at Y MW UCAP (the accreditation is performed from an RTO perspective)
- The New RR is equal to:
 - $\text{New RR} = \text{RR} + (\text{CETO Increase} - \text{Decrease in Internal UCAP})$
 - The CETO increase will be 0 MW
 - The Decrease in Internal UCAP will be Y MW. Therefore,
 - $\text{New RR} = \text{RR} + 0 - Y = \text{RR} - Y$
 - The New RR will be lower than the original RR.

- 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

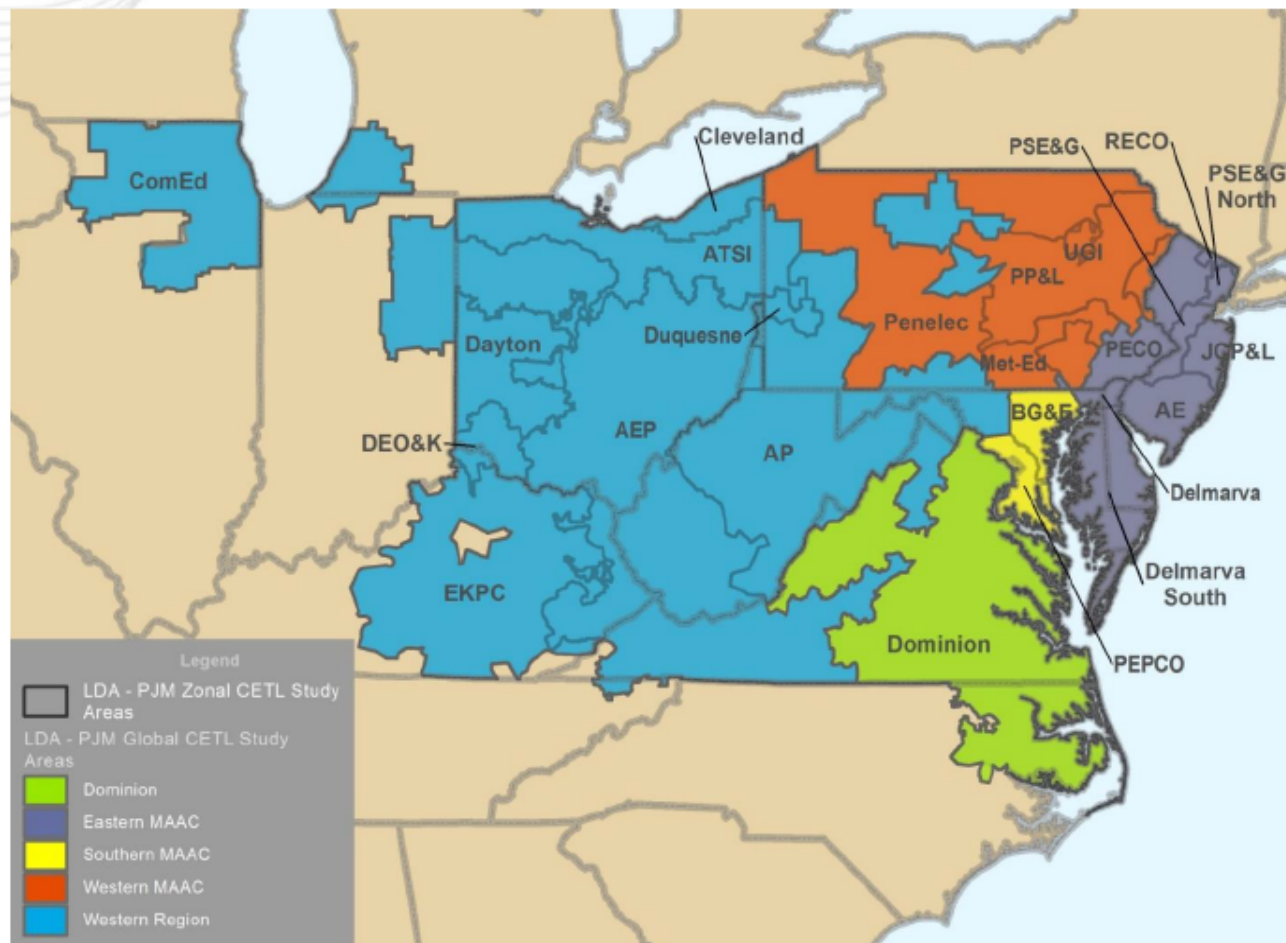


- Annually as part of the RTEP (summer and winter)
- Annually prior the RPM Base Residual Auction
- As needed for Interconnection Requests
- As needed for Incremental Capacity Transfer Rights (ICTRs)
- As needed for Generation Deactivations (pass / fail only)

Capacity Emergency Transfer Objective (CETO): Amount of import capability under peak load emergency conditions into a defined area to maintain a 1-event-in-25-years reliability criteria

- Peak load per PJM Load Forecast
- PJM is divided into 27 “electrically cohesive” Load Deliverability Areas (LDAs). Each LDA is evaluated separately.
- 1-in-25 reliability criteria index refers to the frequency with which the LDA should shed load due to insufficient import capability only.

Capacity Emergency Transfer Limit (CETL) measured against CETO to determine system ability to import capacity into LDA under peak load emergency conditions



If $CETL > CETO$, the LDA passes the test; imports can cover the need.



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



Transmission upgrades can be ordered by the PJM Board.

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

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

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 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

- RMR resource(s) are included in the CETL calculation
- 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 required upgrades will be included in the CETL analysis

- 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

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

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