Effective Load Carrying Capability (ELCC)

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Resource Adequacy Planning
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How to Measure the Capacity Value of a Resource?

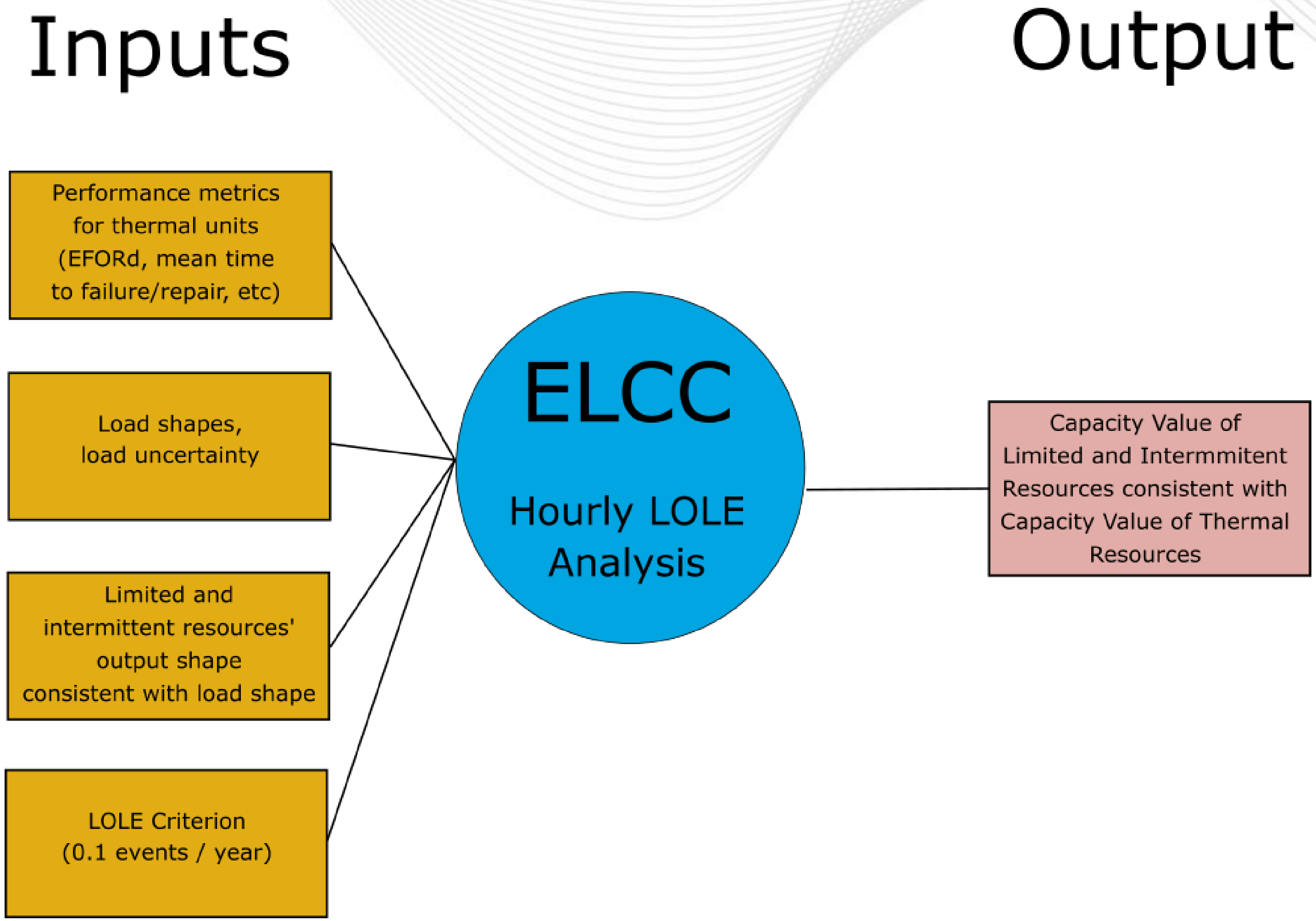
- Resource adequacy of the PJM system is assessed using Loss of Load Expectation (LOLE)
- The main resource adequacy study in PJM is the Reserve Requirement Study (RRS)
- The RRS considers a fixed portfolio of resources P and varies load until LOLE is 0.1 days/year
  - At that point, PJM calculates the IRM (Total ICAP / Peak Load) and the FPR (Total UCAP / Peak Load)
- If a new resource X is added to portfolio P, what is the reliability benefit that such a resource provides?

How to Measure the Capacity Value of a Resource?

- One intuitive way to measure that benefit would be to run a new RRS, using the original portfolio P plus the new resource X
- Clearly, without any changes to the load, the reliability of the PJM system would be better than 0.1 events/year because there is an additional resource (X) in the system
- If the peak load is then increased by an amount L, the reliability of the PJM system will be back at 0.1 events/year.
- Arguably, the additional peak load L that PJM can now serve preserving the reliability of 0.1 events/year is the capacity value or reliability contribution of the new resource X

- Introduced by Garver in 1966, ELCC provides a way to assess the capacity value (or reliability contribution) of a resource (or a set of resources) that is tied to the loss-of-load probability concept
- Can be defined as a measure of the additional load that the system can supply with a particular generator of interest, with no net change in reliability.
  - ELCC can be based on any reliability metric (LOLE, LOLH, EUE)
  - Since PJM uses LOLE, the rest of this presentation will use LOLE

ELCC Inputs/Outputs



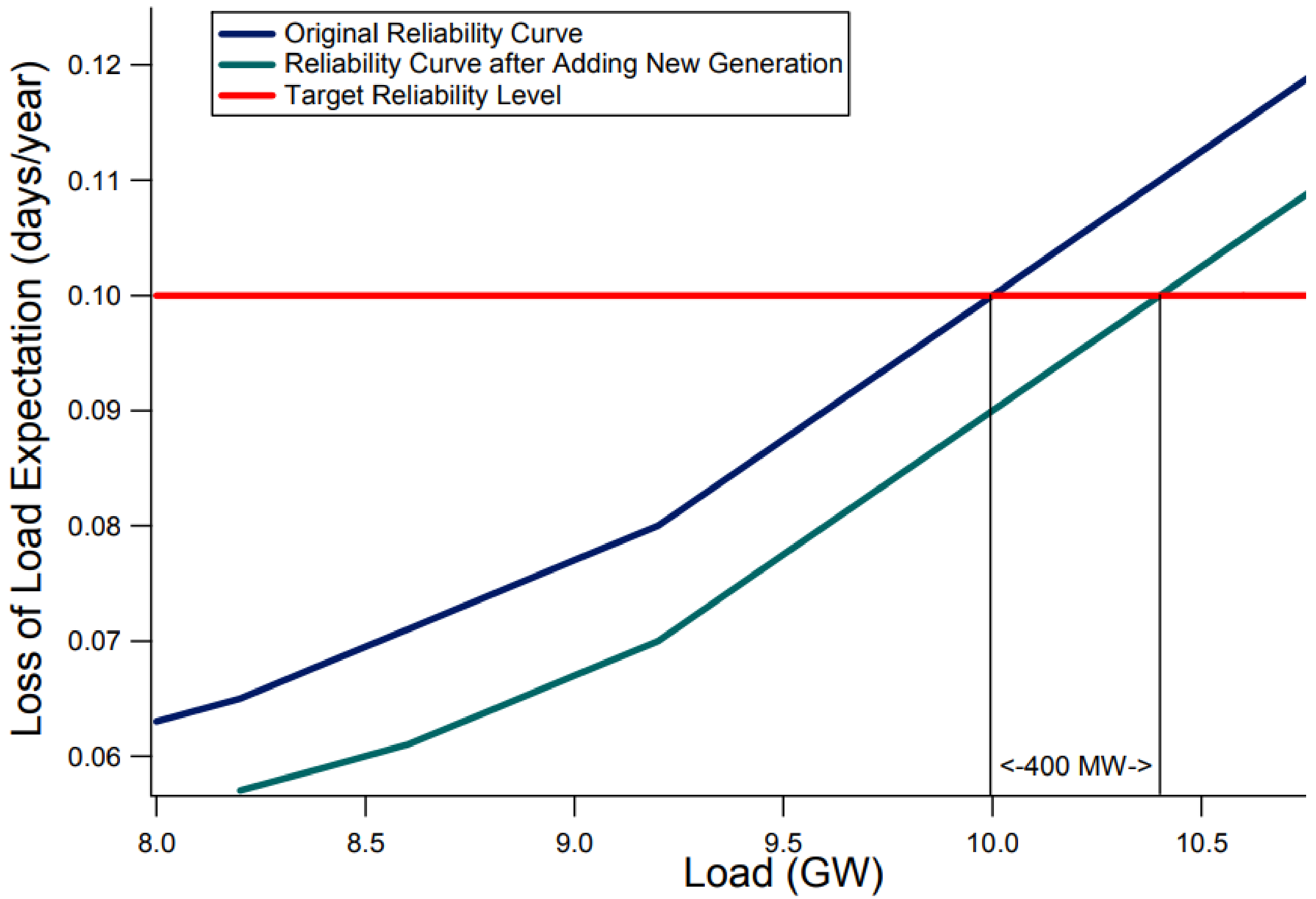


Figure 4. ELCC is the vertical distance between the reliability curves, measured at the target reliability level (400 MW at 1d/10y).

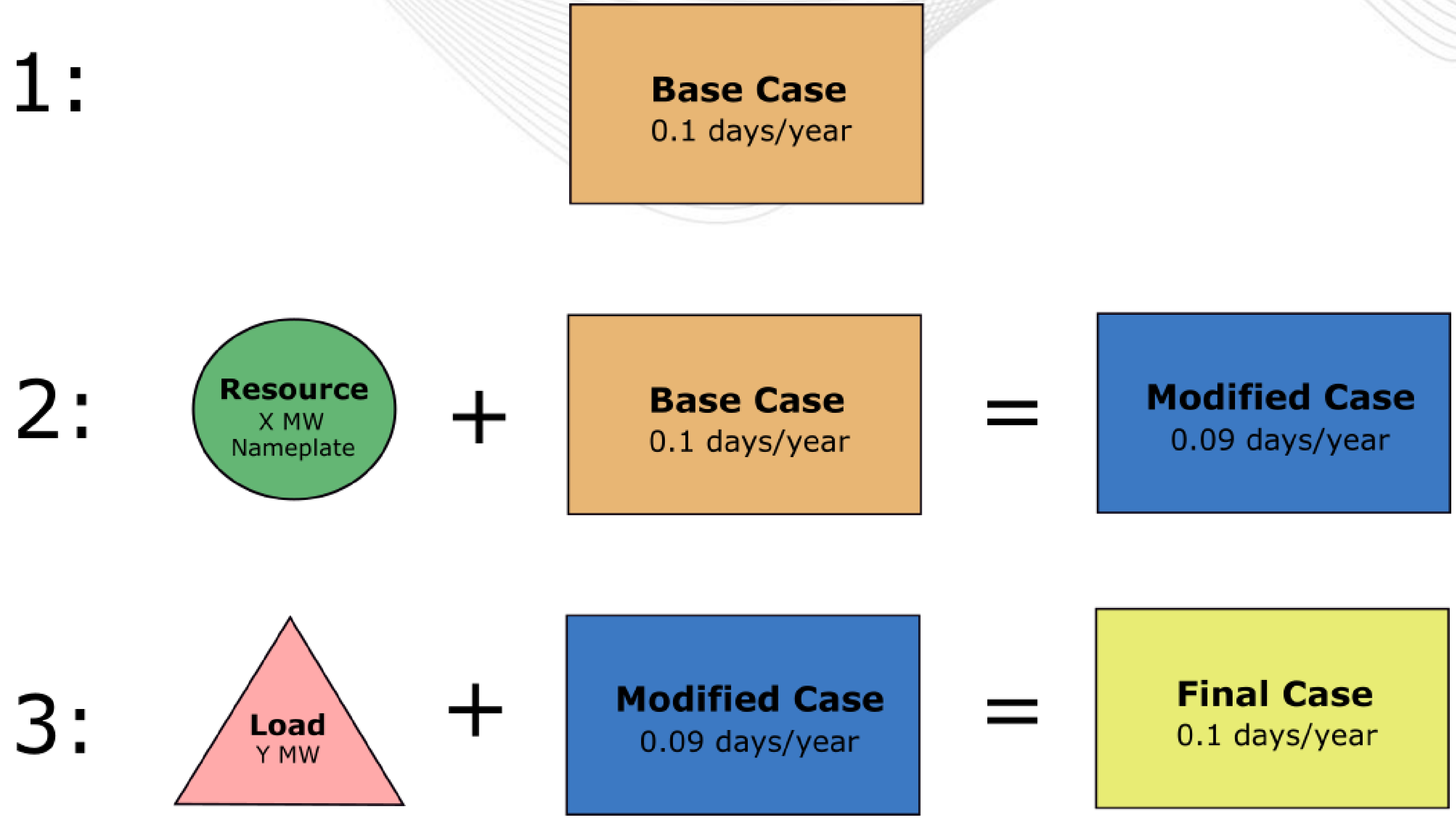
- Prospective analysis; based on inputs for a future target year
- LOLE is driven by the timing of high loss-of-load probability (LOLP) hours. Therefore, ELCC is driven by the timing of high LOLP hours
- A resource that contributes a significant level of capacity during high-risk hours will have a higher capacity value (ELCC) than a resource that delivers the same capacity only during low-risk hours

ELCC Features

- ELCC provides a consistent way to assess the capacity value of resources
  - ELCC of a thermal unit will approximately be its unforced capacity (UCAP) value
  - ELCC can be applied to wind, solar, storage, hybrid resources
- ELCC results are driven by hours with high LOLP. Such hours may vary as penetration of intermittent or limited availability resources increases
  - ELCC captures the “shifting of the net peak load” phenomenon

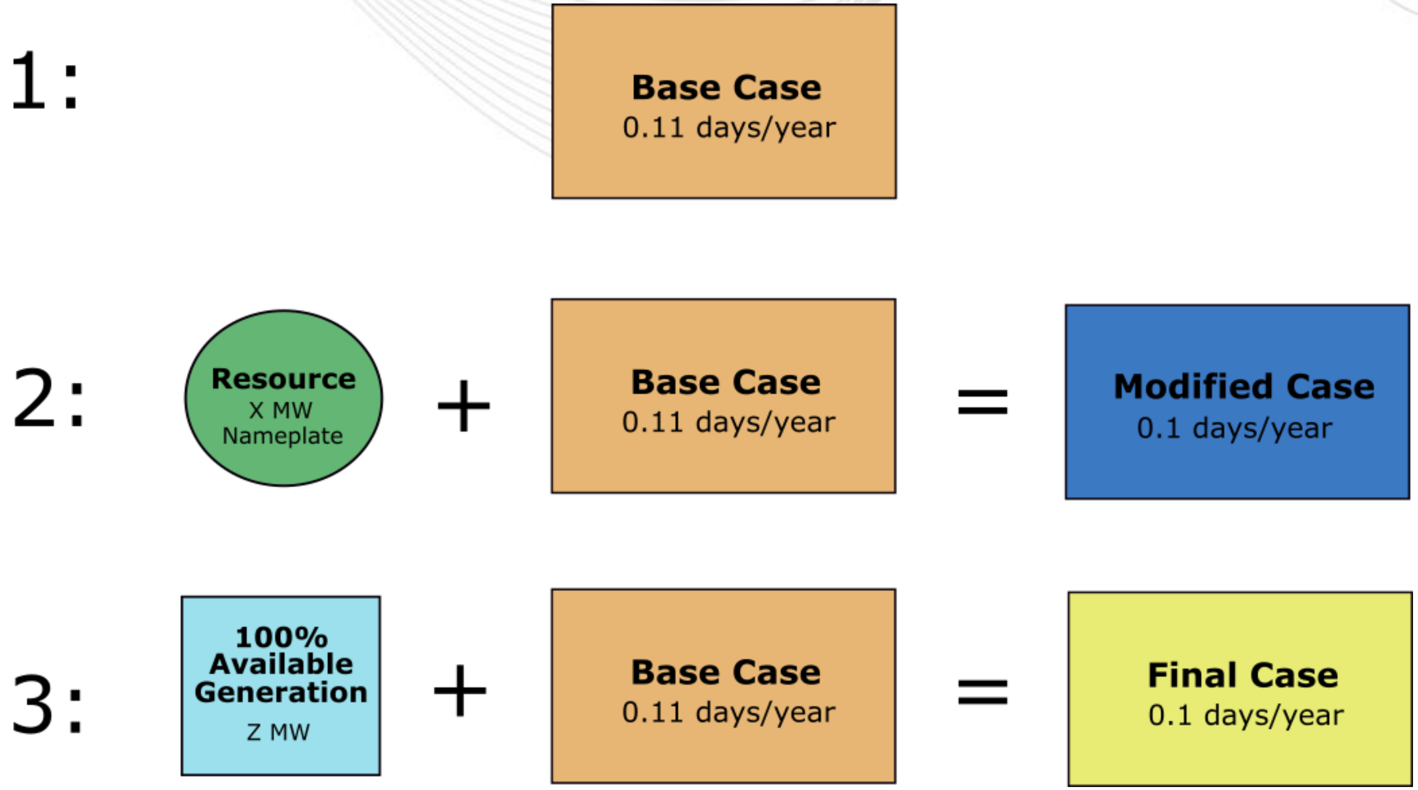
- ELCC requires data showing the performance of the resource of interest at the time of high LOLP hours
  - In the case of renewables, due to high weather variability, several years' worth of data are required
- For dispatchable or new resources, data may be limited or non-existent, so assumptions about the hourly performance of the resource of interest need to be made
- ELCC of an existing intermittent or limited availability resource is likely to decrease as penetration levels of similar resources increase (this is also a feature)

ELCC Approaches – “Load Approach”



The ELCC of the Resource added in Step 2 is the amount of Load added in Step 3 (Y MW). It can be expressed as percent of the Resource’s nameplate (i.e., Y / X)

ELCC Approaches – “Generation Approach”



The ELCC of the Resource added in Step 2 is the amount of 100% Available Generation added in Step 3 (Z MW). It can be expressed as percent of the Resource’s nameplate (i.e., Z / X)

Comparison of ELCC Approaches

- A key difference between the approaches is the resulting ELCC of a 100% available resource (i.e., a resource that produces at its full ICAP the 8,760 hours of a year)
  - Under the Load Approach, the resulting ELCC for such resource is ~93%
  - Under the Generation Approach, the resulting ELCC for such resource is 100%
- Under current RPM rules a 100% available resource is valued at 100% (i.e., its UCAP is equal to its ICAP)
- Therefore, the Generation Approach seems to be more consistent with current RPM rules.

ELCC in Other ISOs/RTOs

- MISO, CAISO, SPP have implemented ELCC for intermittent resources. In general, their ELCC processes involve two steps:
  - Calculating a system-wide ELCC value for the entire wind or solar fleet
  - Allocating the system-wide ELCC value to individual wind/solar units
- NYISO has implemented a capacity credit calculation for storage resources based on ELCC

ELCC at MISO

- MISO only performs ELCC for Wind resources (solar penetration is low)
- MISO calculates an annual system-level ELCC by using 1) historical wind output data since 2005 and 2) current wind penetration level
  - MISO estimates the annual system-level ELCC for each year since 2005 by assuming that the current wind penetration level existed in each of the historical years
  - For 2019-2020, they calculated 14 annual system-level ELCC values (once for each year since 2005 and 2018)
  - The MISO system-level ELCC is the average of the 14 values (currently 15.7%)

- MISO then allocates the system-level ELCC to individual resources as follows
  - For Existing resources, the system-wide capacity credit is calculated as the ELCC (in %) times the total existing nameplate.
    - This system-wide MW capacity credit is then allocated to individual units based on the average output of an individual wind unit during the top 8 daily peak hours in each year for which the unit was in-service
  - For New resources, the capacity credit corresponds to the system-wide ELCC (in %) times the nameplate of the new unit.

ELCC at CAISO

- CAISO performs ELCC for Wind and Solar resources
- CAISO estimates the monthly system-level ELCC under current wind and solar penetration levels
  - Solar ELCC range from 0% (Dec, Jan) to 45% (Jun)
  - Wind ELCC range from 8% (Oct, Nov) to 48% (Jun)

ELCC at CAISO

- CAISO then allocates the monthly system-level ELCC (in %) to individual resources by multiplying the monthly ELCC times the nameplate of the individual resource
  - Therefore, the allocation is not performed based on the actual performance of the individual resource

ELCC for Duration-limited Resources at NYISO
FERC Docket ER19-2276-000, approved Jan. 2020

- **The NYISO proposed capacity values are based on the GE Capacity Value Study as well as the other studies that have been conducted**
  - The NYISO is proposing that the market signal should not incent investment of large quantities of 2 hour resources (i.e. no more than 50% of 4 hour resources)
  - Every year, the NYISO will post the MW tally of new resources with duration limitations to identify if we have hit the transition point
    - Once past the transition point (=> 1000 MW), the 'At and Above 1000 MW' numbers will be used until new values are established

	Incremental Penetration of resources with duration limitations	
Durations (hours)	Less than 1000 MW	At and Above 1000 MW
2	45%	37.5%
4	90%	75%
6	100%	90%
8	100%	100%

NEW YORK INDEPENDENT SYSTEM OPERATOR

https://www.nyiso.com/documents/20142/5375692/Expanding%20Capacity%20Eligibility%20030719.pdf/19c4ea0d-4827-2e7e-3c32-cf7e36e6e34a