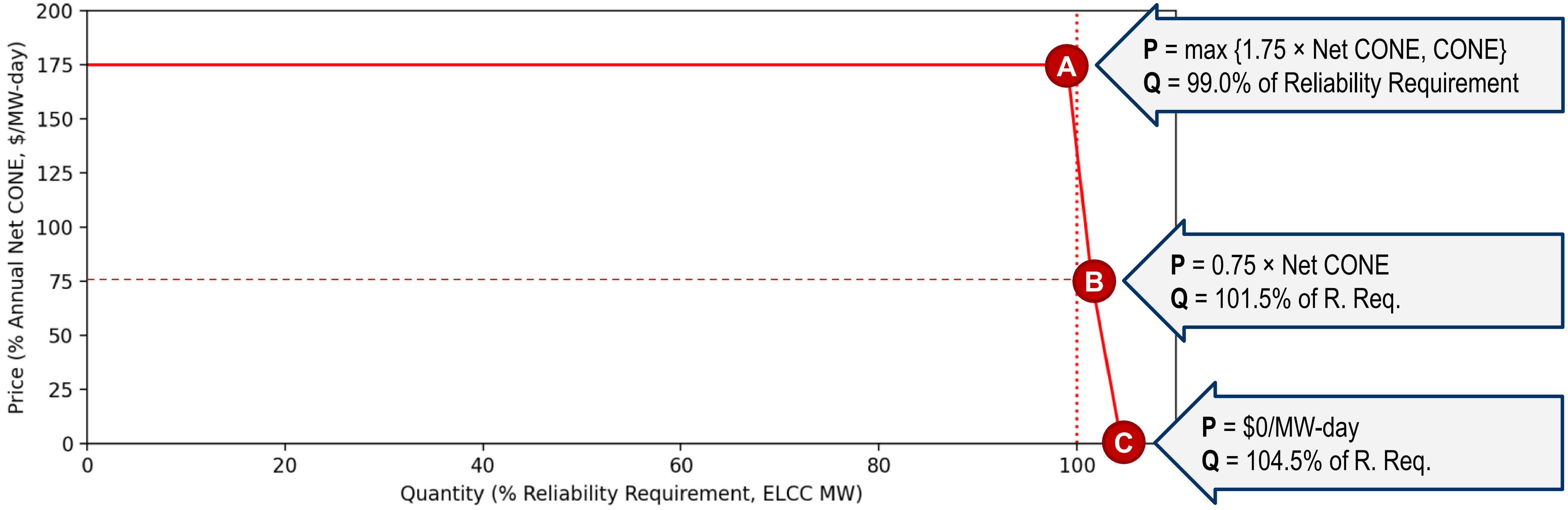
Seasonal Demand Curves

CIFP - Resource Adequacy
August 14, 2023

Purpose of This Presentation

- At the July 27, 2023 meeting we discussed a proposed approach to parameterize seasonal VRR curves to yield results consistent with the current annual demand curve.
- Feedback in that meeting indicated we could have explained that more clearly.
- The purpose of this presentation is to provide a more clear conceptual explanation and support that with analysis.

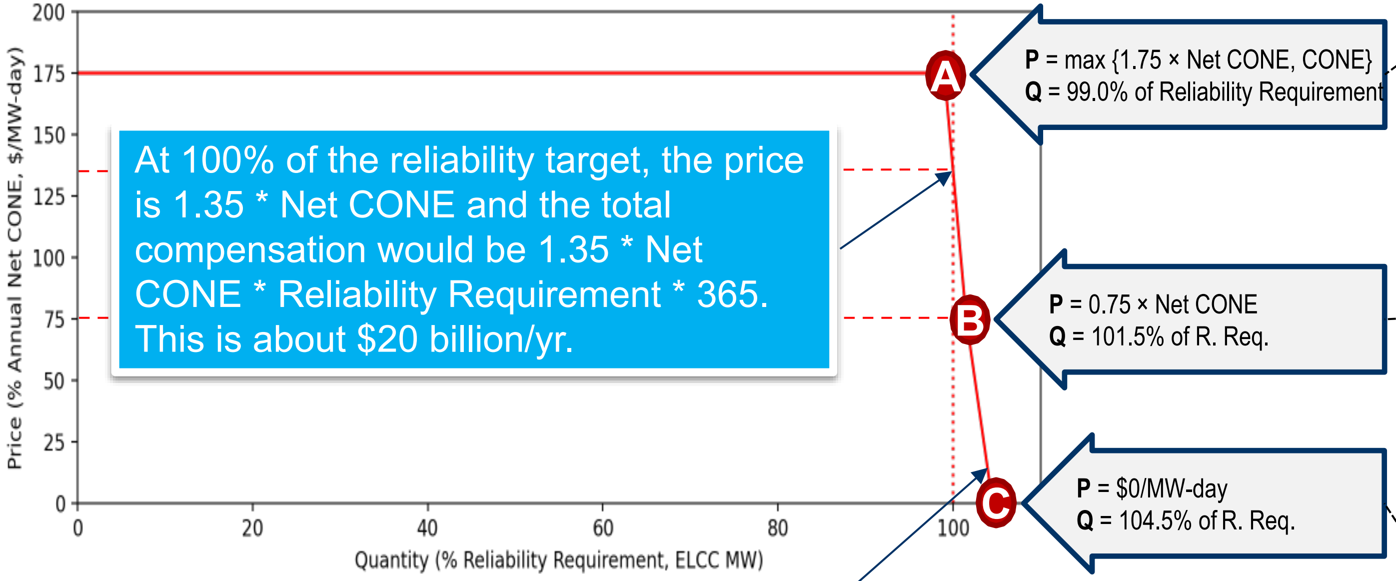
- Annual VRR curve parameters were last adjusted in 2022:



Outcomes Under the Status Quo

- The current market clears annually and therefore the intersection of the **annual supply curve** and **annual demand curve** yield the **annual resource adequacy** level. (Assume RTO-only and 24/25 Planning Parameters)

2024/2025 RTO Demand Curve



Assuming 1.75 * Net CONE > Gross CONE, clearing at 99% of the reliability requirement yields a price of 1.75 * Net CONE such that the total compensation to supply resources is 1.75 * Net CONE * 99% * Reliability Requirement * 365. This is about $26 billion/yr.

Clearing at 101.5% of the reliability requirement yields a price of 0.75 * Net CONE such that the total compensation to supply resources is 0.75 * Net CONE * 101.5% * Reliability Requirement * 365. This is about $11 billion/yr.

Clearing at 104.5% of the reliability requirement yields a price of 0.0 * Net CONE such that the total compensation to supply resources is 0.0 * Net CONE * 104.5% * Reliability Requirement * 365. This is $0.0 billion/yr.

The 24/25 BRA cleared approximately here at ~ 10% of Net CONE.

PJM Proposal from the July 27 Meeting

- There are two adjustments to the **price** used to parameterize demand curves that PJM proposed at the last meeting:
  1. Substitute the class ELCC of the reference resource for pool-wide EFORd in the calculation of Net CONE.
  2. Multiply each price point by 2 to accommodate the seasonal design.

Annual Net CONE: $184/ICAP MW-day *(current 2026/27 default Net CONE)*

– **Summer** Net CONE: $379/UCAP MW-day = $184 ÷ 0.97 ELCC × 2 seasons

– **Winter** Net CONE: $491/UCAP MW-day = $184 ÷ 0.75 ELCC × 2 seasons

Adjustment 1 Adjustment 2

- There is also an adjustments to the **quantity** parameterizing demand curves:
  – Choose seasonal Reliability Requirement as the quantity of seasonal capacity at which the full annual EUE target would be expected to occur in that season
- This presentation focuses on Price Adjustment #2 and the Quantity Adjustment

Changes Under the Seasonal Design

- In the **annual design**, we have a **single clearing outcome** that defines the resource adequacy position for the year and associated compensation.

$$Annual\ Revenues = P_{annual} \times Q_{annual} \times 365\ days$$
$$Annual\ EUE = EUE_{annual}$$

- Under the **seasonal design**, it is the **sum of both seasons** that defines the resource adequacy position and associated compensation.

$$Annual\ Revenues = P_{summer} \times Q_{summer} \times 184\ days + P_{winter} \times Q_{winter} \times 181\ days$$
$$Annual\ EUE = EUE_{summer} + EUE_{winter}$$

Equilibrium in a Seasonal Market

- Typically long-term equilibrium implies clearing around the target reliability.
- Under this definition, there is no single long-term equilibrium because the allocation of the EUE can be different – summer EUE and winter EUE.
  - *Note that for many years historically the industry was concerned almost exclusively about summer risk; procuring enough summer capacity was sufficient to lead to negligible levels of winter risk, given than most resources were annual. So this paradigm is not inconceivable.*
- It follows that any annual outcome has multiple possible seasonal outcomes that result in the same level of annual resource adequacy risk.
- What is constraining is the total cost the load would pay to maintain that level of resource adequacy which is defined by the annual demand curve.

Slightly Different Interpretation Under Seasonal

- The reliability risk and reserve margin cleared in one season are only applicable for that season. The reliability risk corresponding to the cleared resources in each season must be summed to get the total for the RTO.
- It follows that if 100% of the EUE risk is in the summer and 0% in the winter, all of the marginal reliability value from adding a unit of perfect annual capacity stems from reducing summer EUE risk.
- If compensation follows value, regardless of the level of resource adequacy risk or where we clear on the seasonal curves, compensation be expected to come only from the summer (P_{winter} = $0/MW-day) *AND* that compensation level should be consistent with the annual compensation paid today at the same annual resource adequacy level.
- While this is an extreme example for illustrative purposes, it holds true across other outcomes which we will show.

Why Does This Work

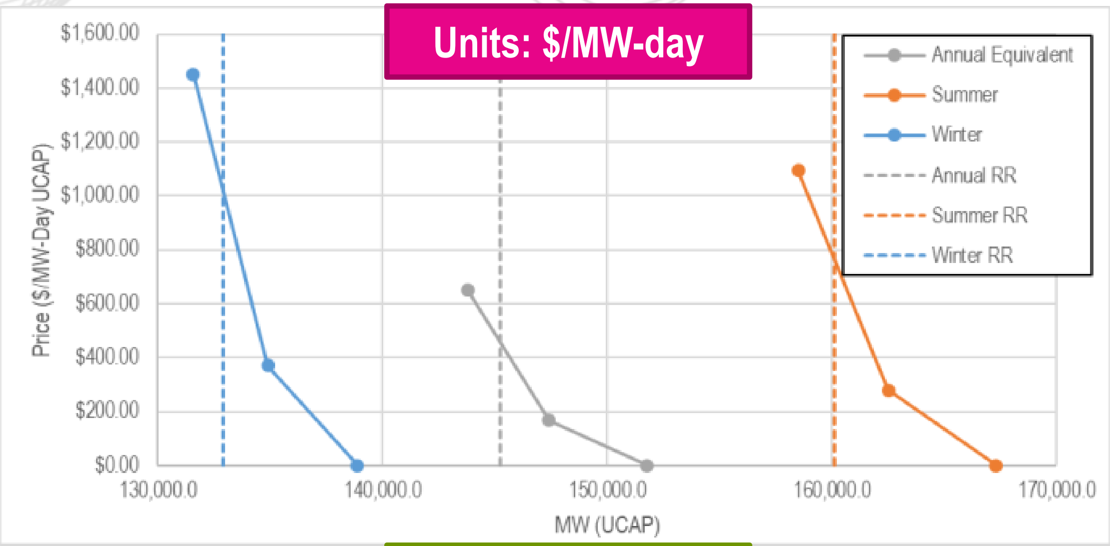
- More generally, the effect that is occurring is that the **annual demand curve sets total annual dollar quantity** associated with **a level of resource adequacy** (or resource adequacy risk) that is **compensated for over an entire year** – even if the contribution to system reliability is focused on a small subset of that year.
- The seasonal model allows for the costs associated with the portions of EUE that occur in each season to be identified and compensated for in that specific season.
  - Thinking of this as a decomposition of the annual model may be helpful.
  - Some portion of the total dollars paid for a level of annual resource adequacy correspond to the resources providing that value in each season.
- When these annual costs are paid out over a single season, the rate ($/MW-day) increases, but number of days over which those costs are paid decrease
- Consider an energy only market where a new entrant must rely on scarcity revenues in very few hours. The less hours of scarcity there are, the higher the rate must be in the scarcity hours to provide the necessary revenues to attract the new entrant. This is the same issue.

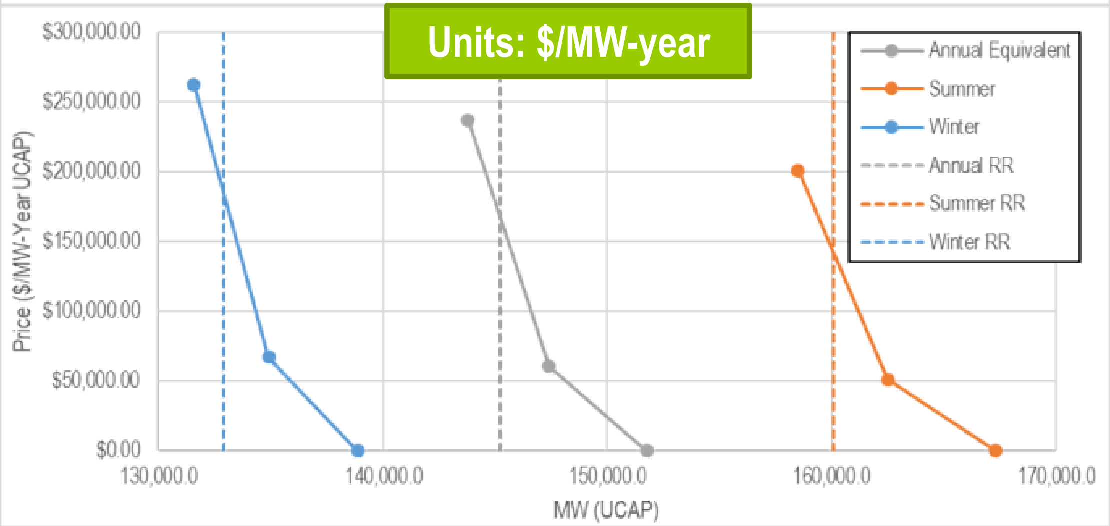
Examples with Representative Parameters

Comparison of Seasonal and Annual Demand Curves Reflecting Latest Risk Analysis

- Representing the VRR curves in $/MW-Day UCAP (as at right) seems to imply that the seasonal VRR curves can yield costs that are twice that of the Annual VRR curve.
- But the total cost associated with clearing at the reliability requirement (RR) under each VRR curve is calculated by multiplying the number of days in each relevant period
  - **Annual Period:** 365 Days
  - **Summer Period:** 184 Days
  - **Winter Period:** 181 Days
- So the costs for clearing at the RR are nearly equal

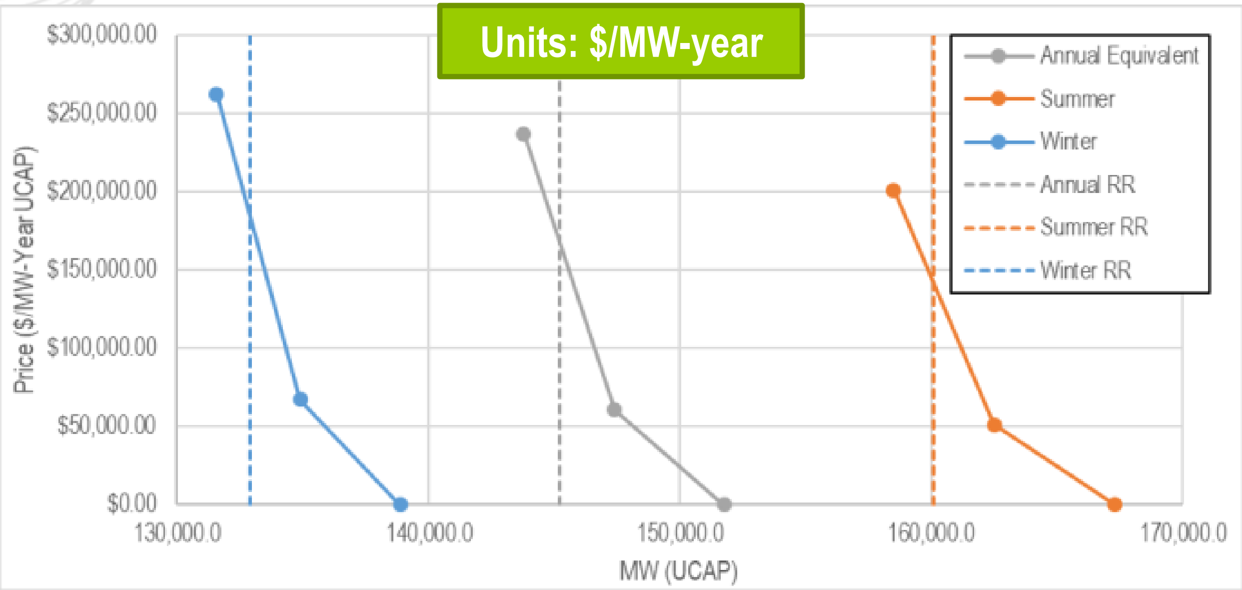
Converting price units to $/MW-Year helps demonstrate how similar the costs are between curves (see right)





Comparison of Seasonal and Annual Demand Curves Reflecting Latest Risk Analysis *(continued)*

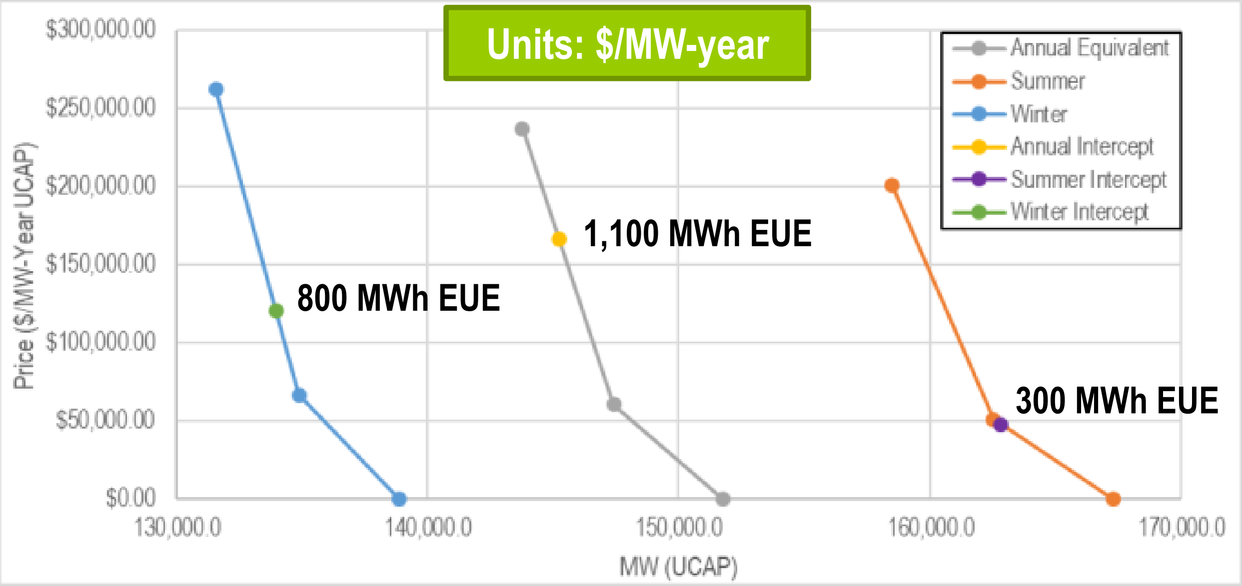
- The VRR curves are parameterized such that clearing at the Summer, Winter, or Annual Reliability Requirement yields the full annual EUE target.
- The prices on each VRR curve at the MW quantity corresponding to the EUE MWh target (1,100 MWh) in $/MW-Year are:
  - **Annual Cost:** ~$160,000/MW-Year
  - **Summer Cost:** ~$140,000/MW-Year
  - **Winter Cost:** ~$180,000/MW-Year



- Differences are due to ELCC accreditation of the Reference Resource, which affects Point A of the max of Gross CONE or 1.75 x Net CONE, and Reliability Requirement for each VRR curve.
  - Higher ELCC accreditation lowers Net CONE
  - The Reliability Requirement is dependent on the amount of accredited UCAP needed to meet the full annual EUE MWh target in each season.

Illustrative Clearing Outcome at the Annual Reliability Requirement

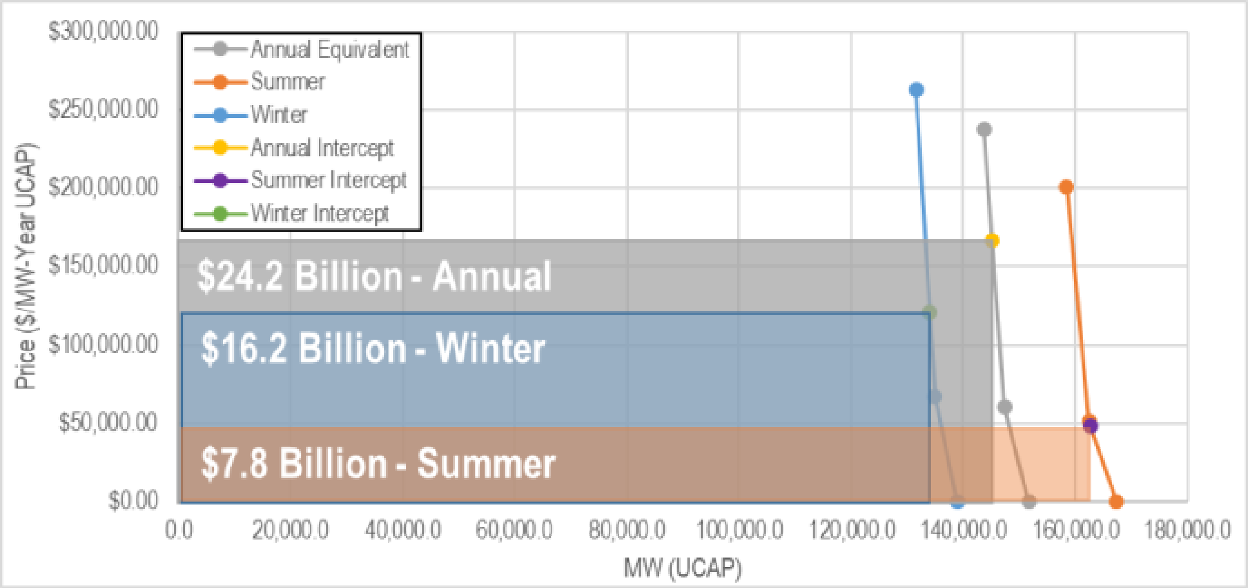
- Clearing at the Annual Reliability Requirement is compatible with clearing at many different combinations of Summer and Winter capacity. Clearing at the Annual Reliability Requirement is equal to having a risk of 1,100 EUE MWh.
- Alternatively, we can clear at different points along the Summer and Winter VRR Curves to equal the same 1,100 EUE MWh annual outcome.



- **Representative example:** 800 MWh EUE is met by clearing at the green intercept on the Winter VRR curve, and 300 MWH EUE is met by clearing at the purple intercept on the Summer VRR curve.
- **This distribution of summer & winter relative risks is consistent with resource mix assumed in risk modeling & accreditation analysis** but is not the only way the market could clear, NOR even is it the only way the market could clear and still yield exactly 1,100 MWh EUE of annual load shed risk; many different seasonal combinations.

Seasonal and Annual Capacity Costs

- **Total costs are nearly equal** when clearing on the Annual VRR curve or Seasonal VRR curves.
  - **Annual Costs:** $24.2 Billion
  - **Summer Costs:** $7.8 Billion
  - **Winter Costs:** $16.2 Billion
- The sum of the Summer and Winter costs equals $24.0 billion, while the Annual costs equal $24.2 billion.



- Similarly, total seasonal costs (at any combination of summer and winter clearing outcomes) would nearly equal total annual costs (at an annual clearing outcome corresponding to the same total annual EUE)

Seasonal vs. Annual Capacity Costs: Another Perspective

1. Start with seasonal clearing results: prices, quantities, & total costs

Summer	Winter
$7.8 Billion	**$16.2 Billion**
$262/MW-Day	*$663/MW-Day*
162 GW	*134 GW*

2. Annualize prices

$7.8 Billion	**$16.2 Billion**
$131/MW-Day Annually	*$331/MW-Day Annually*
162 GW	*134 GW*

3. Translate seasonal results to annual

$7.8 + $16.2 = $24 Billion

$131/MW-Day Annually + $331/MW-Day Annually
= $462/MW-Day Annually

4. Compare to annual clearing at RR

$24.2 Billion

$457/MW-Day Annually
145 GW Summer Capacity

** Note: annual equivalent prices slightly different between steps 3 and 4 due to applying to different MW quantities*