Technical Working Group #3: Demand Curve Shape Analysis

May 04, 2018

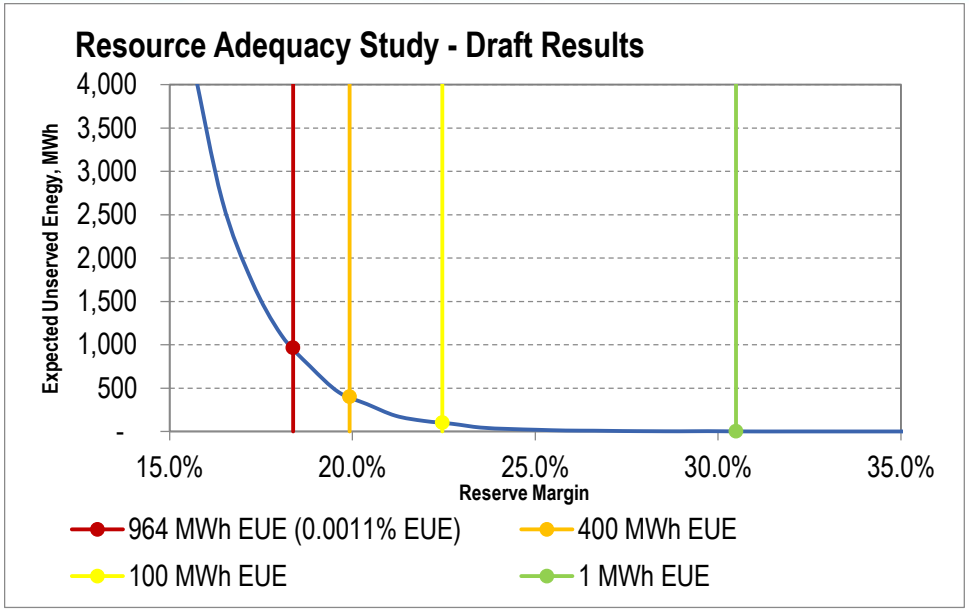
Intent

- Develop a shared understanding of the rationale for the proposed demand curve shape
- Provide further explanation as to why the demand curve is offset/right shifted at 1.0 x Net CONE

Outline

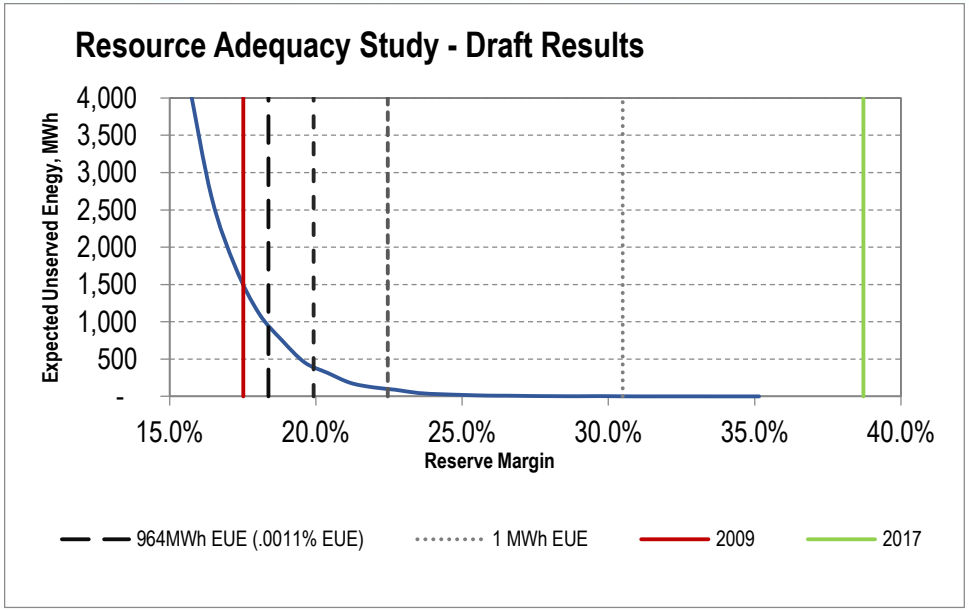
- Resource Adequacy Considerations
- Demand Curve Performance
  - Desired characteristics
  - Simulation results
- Test specific shapes
  - Shortcomings of vertical curve, deeply convex curve
  - Reasoning for selecting proposed curve
  - Reasoning for right shifting the curve

Resource Adequacy Study Draft Results



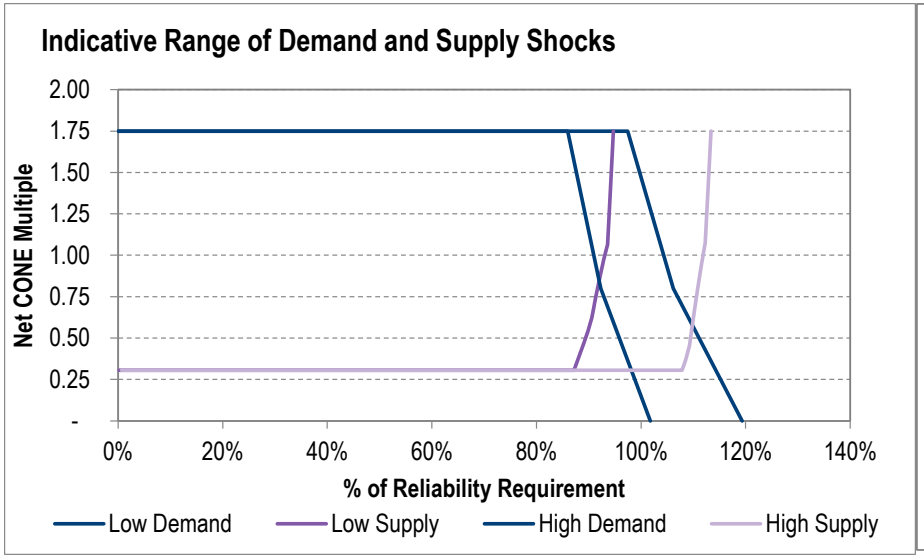
- Expected Unserved Energy (EUE) is measured in MWh at various Reserve Margin levels
- EUE increases exponentially as Reserve Margin declines

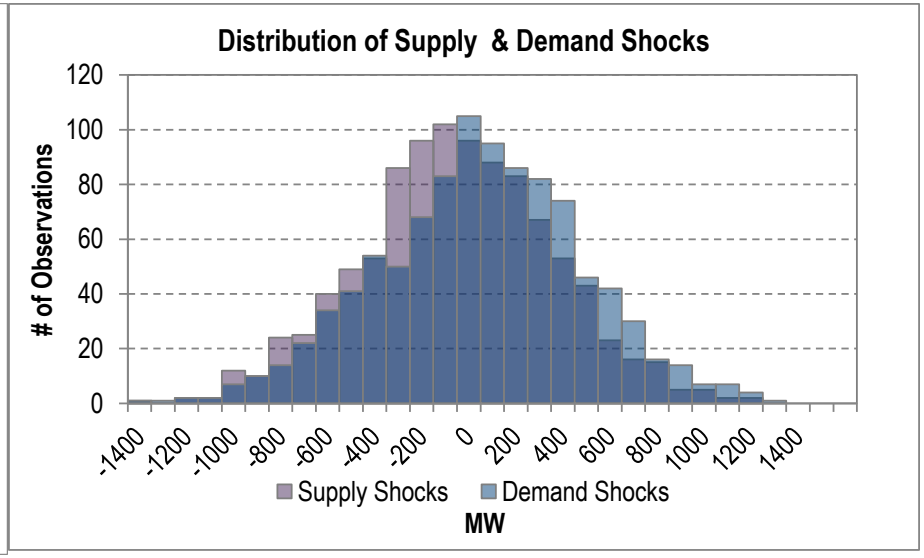
Resource Adequacy - Historical



- The historical range for resource adequacy has been 17.5% to 38.7% reserve margin between 2008 and 2017
- The range of the proposed demand curve is between 18.7% and 30.5%, within the historical reliability range over the past decade

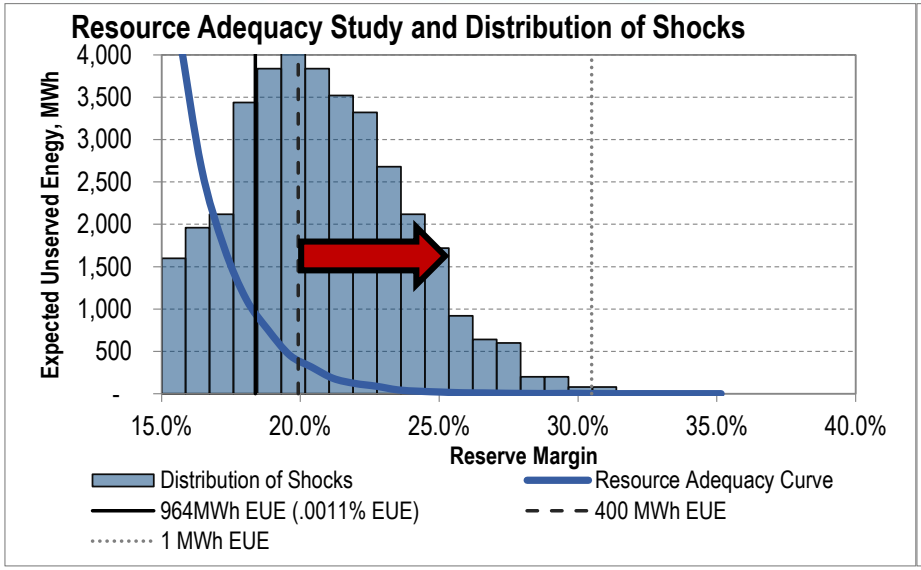
Supply & Demand Shocks

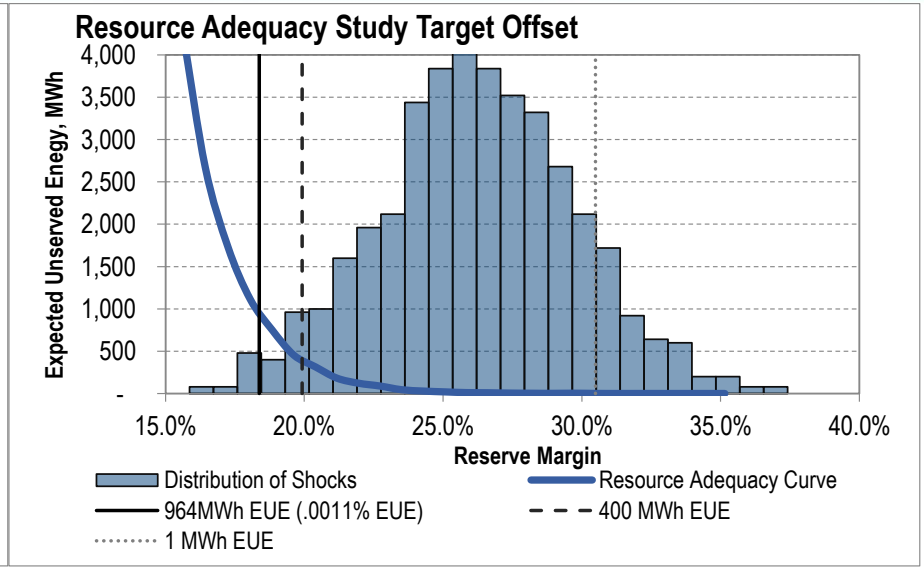




- Supply shocks are based on historical retirements and additions
- Demand shocks are based on load forecast errors
- Demand and supply shocks follow normal distributions
- These shocks are used in the Monte Carlo simulation to evaluate average performance of demand curves

Resource Adequacy – Supply Shocks and Target Offset





- Expected unserved energy grows exponential when supply is scarce
- The distribution of shocks is approximately normal
- As a result, a demand curve with the target set at the target reserve margin of 400MWh EUE and 1X Net CONE will not achieve 400MWh EUE on average
  - A target set at 400 MWh EUE would achieve 2400 MWh EUE on average
- The asymmetry of the Resource Adequacy curve requires an offset of approximately 5% to achieve the resource adequacy target **on average**

Resource Adequacy Target

- The Government has provided a minimum reliability standard of 0.0011% unserved energy
  - This equates to a minimum of approximately **964MWh EUE** in the reference year
- A target level has not yet been defined, but a range of 100MWh EUE to 400 MWh EUE has been tested

Select Demand Curve Evaluations

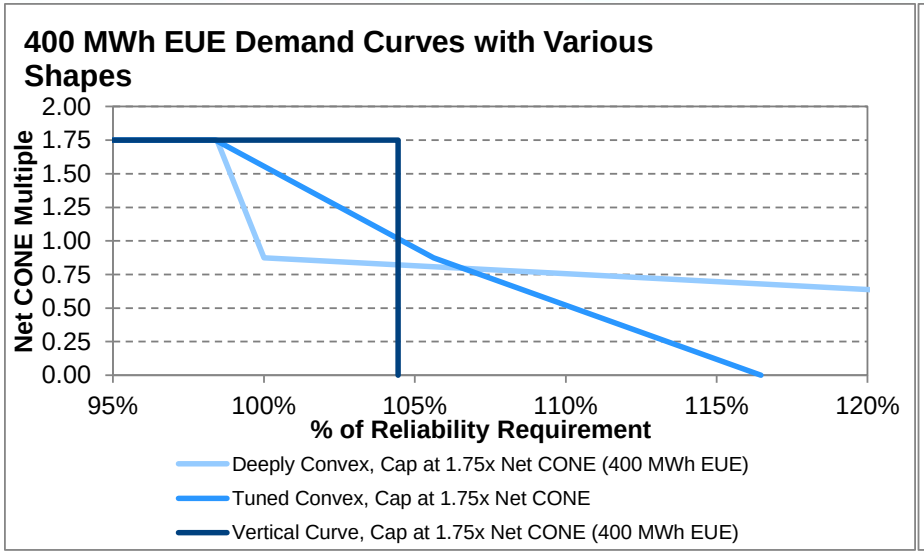
Demand Curve Performance

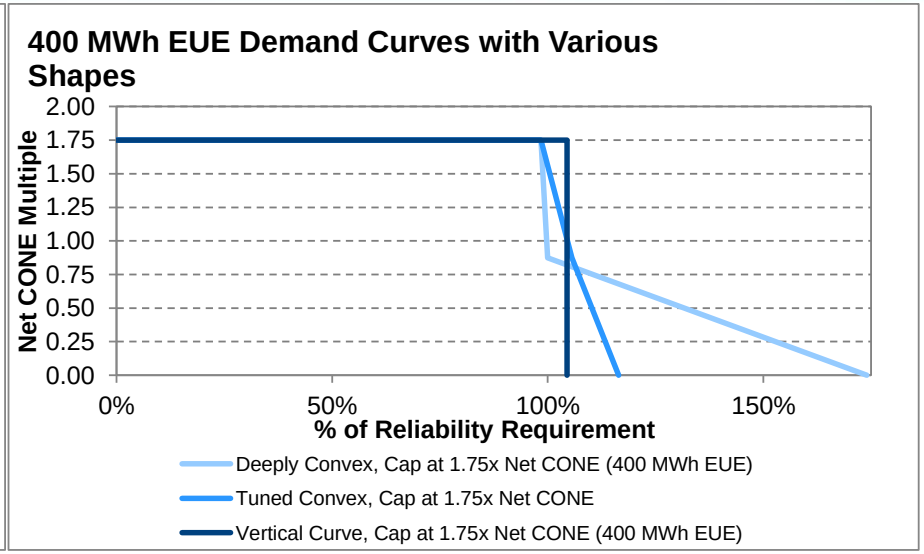
- In line with the Demand Curve Principles developed in SAM 3.0, a demand curve can be considered to perform well if it:
  - ☑ Can accommodate shocks in supply and demand
  - ☑ Performs consistently to a reliability target, and typically above the minimum reliability standard
  - ☑ Accommodates a wide range of possible outcomes, with changes in supply, allowing for a well functioning and competitive market
  - ☑ Minimizes the scope of market power exercise
  - ☑ Provides adequate revenue to incent entry and exit when required i.e. leads to the ‘right’ level of capacity

Demand Curve Evaluation

- Market Conditions are simulated using a Monte Carlo simulation model
  - Model solves to an average price of net cone
  - Tests the impacts of supply/demand shocks on price and reliability outcomes under various demand curves
- Key ‘characteristics’ are evaluated to assess if the curve is meeting the performance requirements
  - Price Volatility
  - Cleared capacity
  - Average reliability, and frequency

Selected Curves for Review

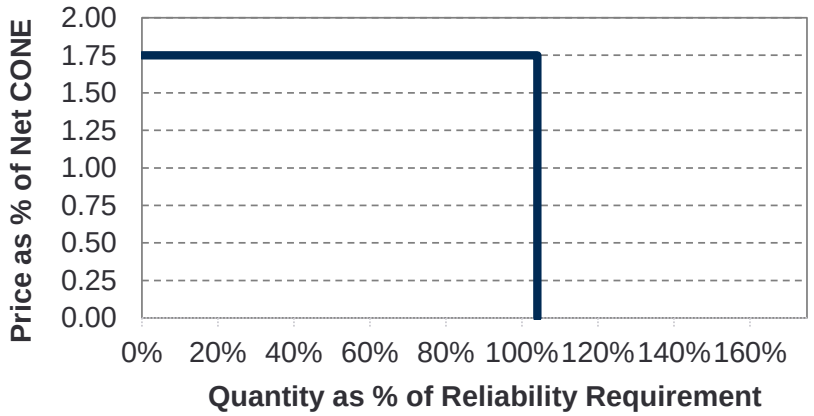


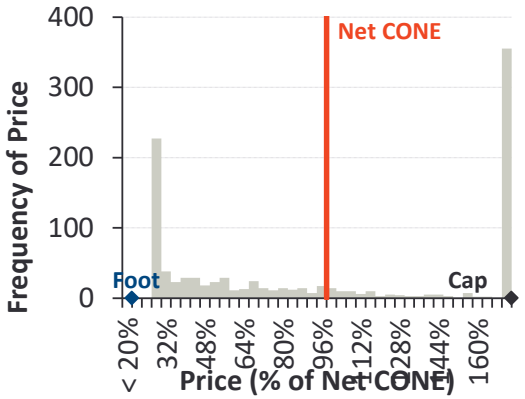


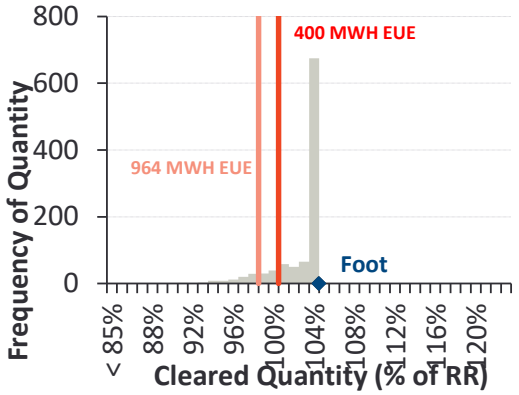
- Several shapes of downward sloping demand curves were tested to reveal their merits and shortfalls
- Vertical , Deeply Convex, and the CMD1.0 Proposed Curve are evaluated
- Each of these curves performs to the 400 MWh EUE reliability level on average over 1,000 simulations
  - Proposed Curve with 100 MWh EUE also tested
- Each curve maintains a price cap of 1.75X Net CONE

Vertical Curve

Vertical Curve, Cap at 1.75x Net CONE (400 MWh EUE)





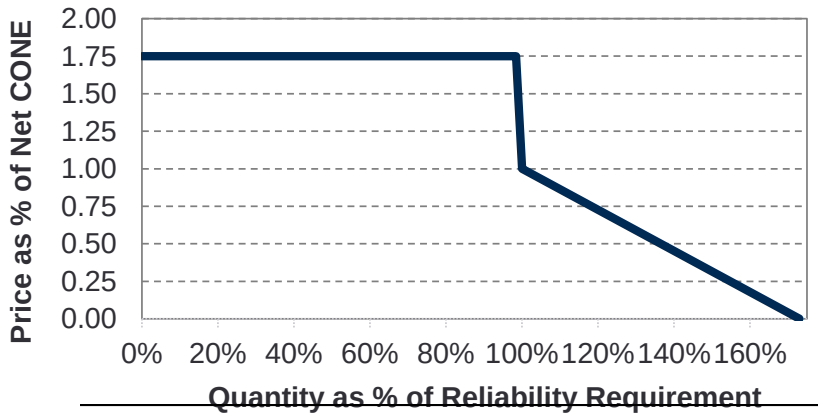


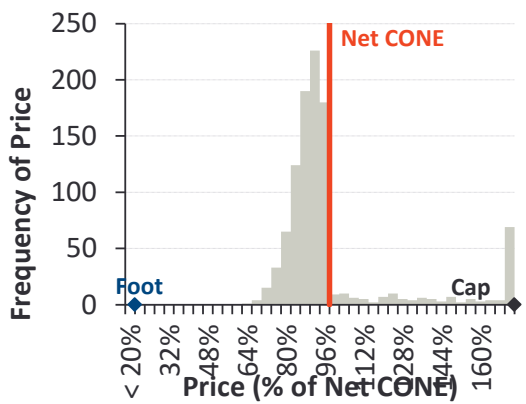
	Price			Reliability					
Demand Curve	Average ($/MW-d)	Standard Deviation ($/MW-d)	Frequency at Cap (%)	Average EUE (MWh)	Average LOLH (Hours)	Average Quantity as % of Rel. Req. (%)	Average Excess (Deficit) Above Rel. Req. (MW)	Average Uncleared Supply (MW)	Frequency Below Rel. Req. (%)
Vertical Curve, Cap at 1.75x Net CONE (400 MWh EUE)	$381	$236	35%	400	1.3	103%	353	446	11%
Tuned Convex, Cap at 1.6x Net CONE	$381	$128	7%	402	1.3	105%	578	237	13%
Tuned Convex, Cap at 1.75x Net CONE	$381	$153	7%	402	1.3	105%	539	257	13%
Tuned Convex, Cap at 1.9x Net CONE	$381	$175	6%	400	1.3	105%	505	281	13%

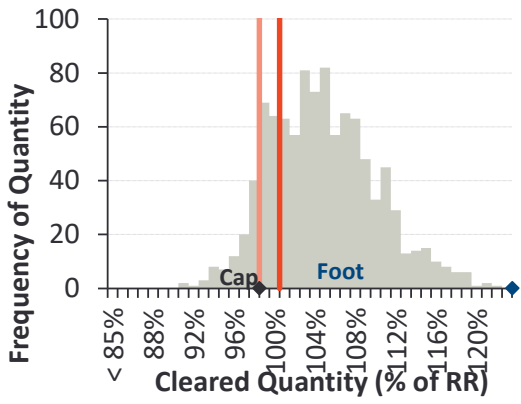
- A vertical curve produces significant price volatility, with no change in procurement level
  - Vertical curve is perfectly inelastic
- Vertical curve is not robust to load forecast errors in resource adequacy modeling
- Price outcomes are heavily concentrated in the low % of Net CONE range & price cap
- Highly susceptible to market power exercise, since any change in volume can materially change price

Demand Curve with Inflection Point Set at 1.0X Net CONE and 100% of the Reliability Target

Deeply Convex, Cap at 1.75x Net CONE (400 MWh EUE)







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Deeply Convex, Cap at 1.75x Net CONE (400 MWh EUE)	$382	$94	6%	399	1.2	105%	599	212	16%
Tuned Convex, Cap at 1.6x Net CONE	$381	$128	7%	402	1.3	105%	578	237	13%
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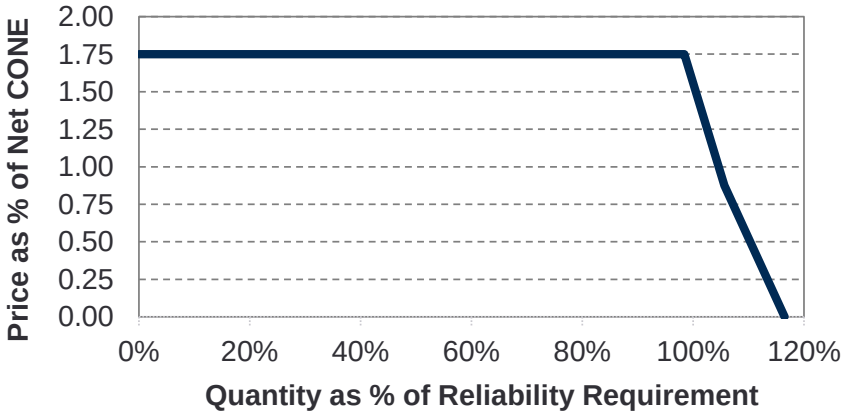
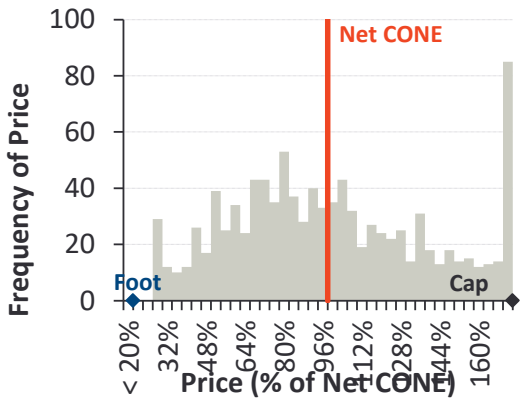
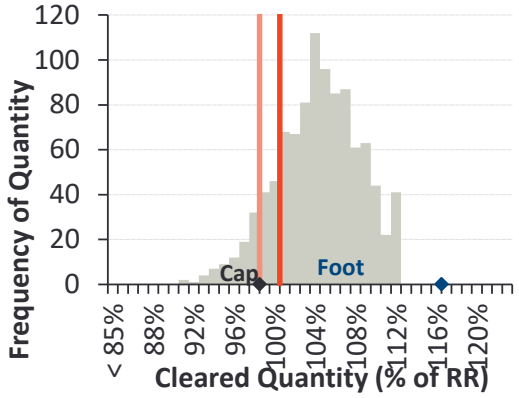
- With the inflection point at 1.0X Net CONE and 100% of the reliability target requires a deeply convex curve to meet reliability outcome
  - The foot is meaningfully wider and longer than the middle section, skews price outcomes to the foot
- Provides a very small buffer to errors in net CONE estimation and resource adequacy modeling
- Tends to procure more supply than a less convex curve
- Has a high frequency of occurrences below the reliability requirement
- The steepness of the curve above Net CONE is highly susceptible to market power exercise, like the vertical curve

Proposed 1.75X Net CONE Convex Curve: 400 MWh EUE

Tuned Convex, Cap at 1.75x Net CONE







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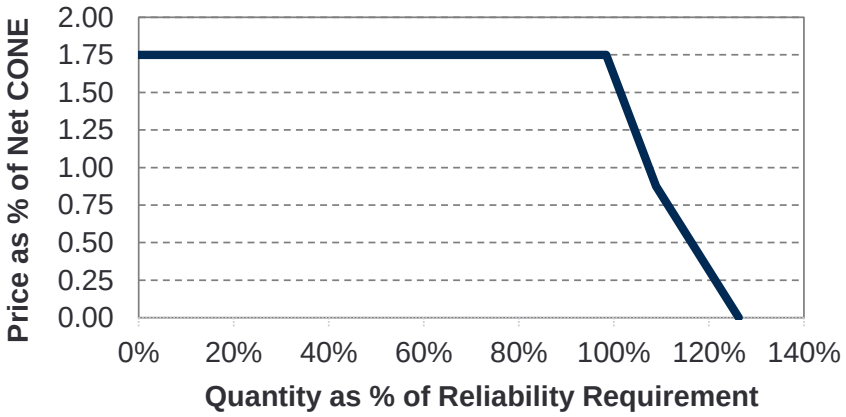
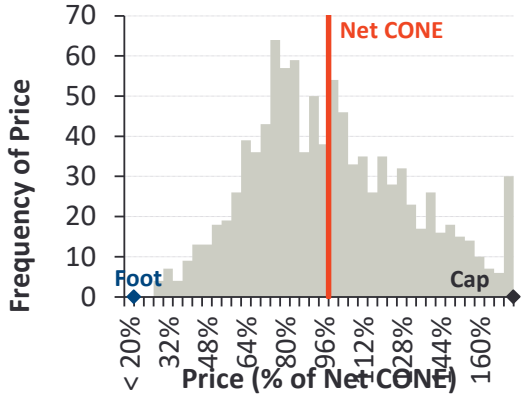
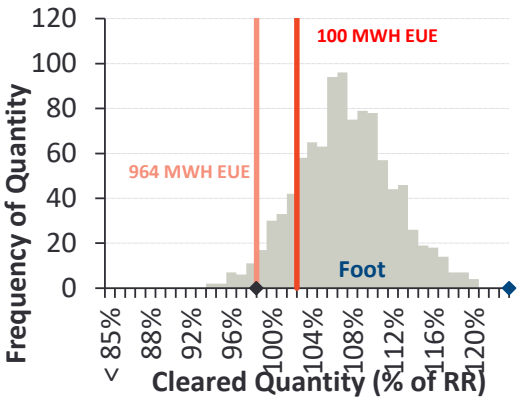
- A slightly convex curve provides a robust range of price outcomes
  - Inflection point 5-6% above reliability requirement target level
- Reflects increasing value of capacity in times of scarcity
- Width helps mitigates market power exercise
- Amount of time market clears below minimum reliability requirement a concern
- Provides a meaningful buffer to errors in net CONE and resource adequacy modeling

Proposed 1.75X Net CONE Convex Curve: 100 MWh EUE

Tuned Convex, Cap at 1.75x Net CONE (100 MWh EUE)







	Price			Reliability					
Demand Curve	Average ($/MW-d)	Standard Deviation ($/MW-d)	Frequency at Cap (%)	Average EUE (MWh)	Average LOLH (Hours)	Average Quantity as % of Rel. Req. (%)	Average Excess (Deficit) Above Rel. Req. (MW)	Average Uncleared Supply (MW)	Frequency Below Rel. Req. (%)
Tuned Convex, Cap at 1.75x Net CONE (100 MWh EUE)	$382	$122	2%	100	0.2	108%	874	229	4%
Tuned Convex, Cap at 1.6x Net CONE	$381	$128	7%	402	1.3	105%	578	237	13%
Tuned Convex, Cap at 1.75x Net CONE	$381	$153	7%	402	1.3	105%	539	257	13%
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- A 100 MWh EUE convex curve reduces the frequency below the minimum reliability requirement
- The foot of the 100 MWh EUE curve increases from 116% to 126% of reliability target
- Provides a relatively normal distribution of prices an quantities

Conclusions

- A downward-sloping, convex, demand curve is preferred to vertical curve
- Too much convexity can cause concentration of the price outcomes below Net CONE
- Very steep curves enable market power exercise
- Stakeholder concerns regarding over procurement in CMD 1.0 proposed curve
  - Proposed curve clears below minimum resource adequacy standard 6.5% of iterations
- AESO continues to evaluate resource adequacy target and demand curve shapes
  - Continued feedback welcomed