Sixth Review of PJM's RPM VRR Curve Parameters

UPDATED GROSS CONE AND VRR CURVE ANALYSIS

PREPARED BY

The Brattle Group

Sam Newell
Kathleen Spees
Andrew W. Thompson
Ethan Snyder
Xander Bartone
Nathan Felmus
John Higham

Sargent & Lundy

Joshua Jungé
Hyojin Lee

PRESENTED TO

PJM Market Implementation Committee

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Brattle

Where we are in the Net CONE and VRR Review

2024

September 27th
Virtual
Overview and VRR Curve Presentation

October 24th
Virtual
Reference Technology Presentation

November 26th
Virtual
Preliminary CONE and E&AS Presentation

December 17th
In person
Updated CONE/E&AS and VRR Curve Concepts Presentation

2025

January 29th
Virtual
Cancelled

February 21st
Virtual
Updated CONE and VRR Shape Presentation

March 11th
Virtual
Near Final CONE/E&AS and VRR Presentation

April 8th
Virtual
Final CONE/EAS and VRR Reports Presentation

May onward
PJM Board Vote and filing date for VRR parameters

Draft Recommendations posted **Early March**

Final Word Reports posted **April 8th, 2025**

1 Net CONE Updates

2 MRI Curves Tuned to 1-in-10

3 Price Cap Considerations

4 LDA Curves

5 Next Steps

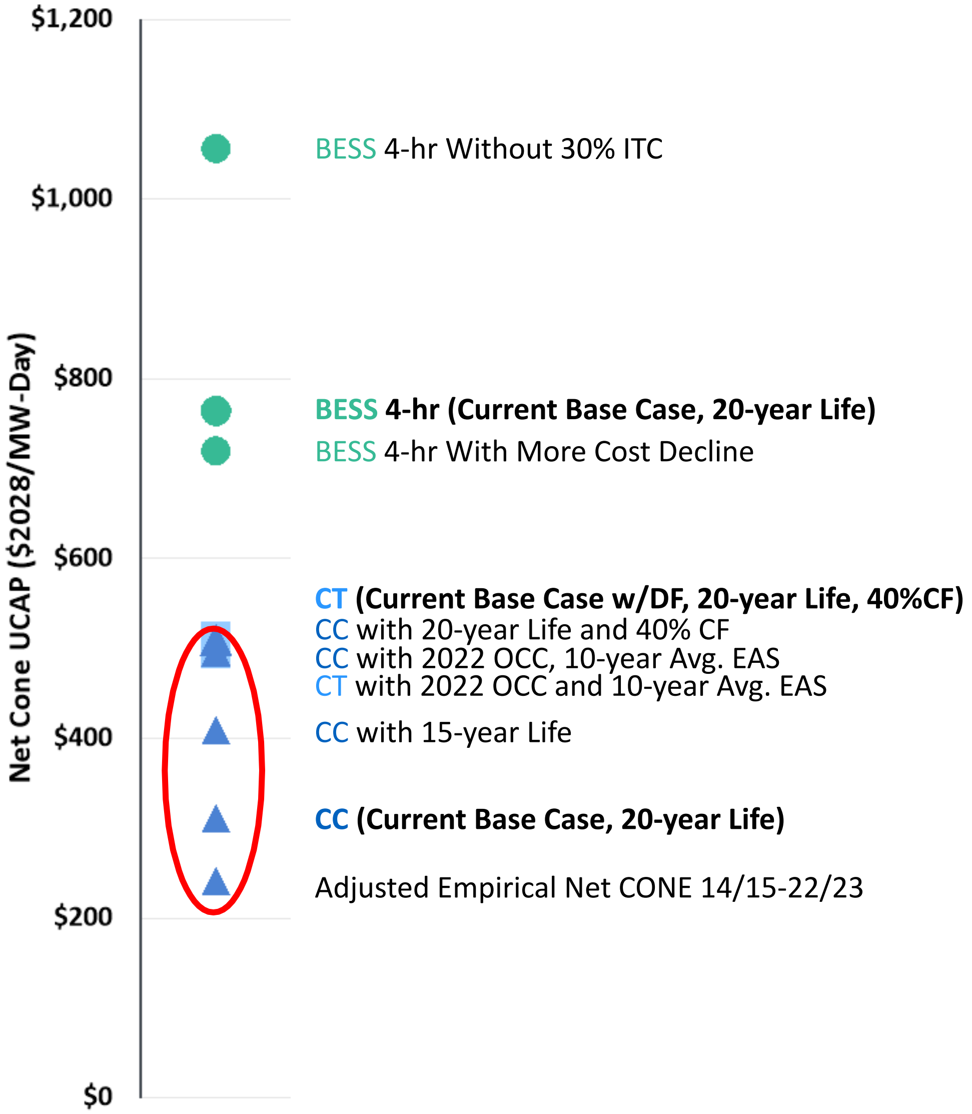
Recap from December 17, 2024 MIC: Summary of Updates

- Finish **updating preliminary costs line items** for CC, CT, and 4-hr BESS
  - Overnight Capital Costs, including:
    - Net Startup Fuel Costs (**complete)**
    - Electrical Interconnection (**complete)**
    - Gas Interconnection (**updated with small refinement planned for March final report**)
    - Fuel Inventories (**complete)**
    - Working Capital (**complete)**
  - Fixed Operations and Maintenance Costs, including:
    - Property Taxes or Land Lease (**complete)**
    - Firm Gas Transport (**complete)**
- **Adjust escalation period for** Owner Furnished Equipment (CC/CT) and BESS Equipment (4-hr BESS) capital costs to only 5-6 months instead of mid-point of construction period (**complete**)
- Confirm if **property taxes** are a good proxy for BESS land lease costs (**complete**)
- Consider further refinements to **BESS augmentation** costs (**complete**)
- Further consider **uncertainties** re asset life, permitting, and EAS offsets (**complete**)
- Propose method and parameters on **annual updates** (**planned for March final report**)
- Complete **ATWACC** study and incorporate into CONE analysis (**planned for March final report**)

Technology	Overnight Capital Costs	Capital Charge Rate	Year-1 Capital Recovery	Levelized FOM	CONE ICAP	E&AS Offset	Net CONE ICAP	ELCC	Net CONE UCAP
Nominal$ for June 2028 COD	**($/kW)**	**(%/year)**	**($/MW-day)**	**($/MW-day)**	**($/MW-day)**	**($/MW-day)**	**($/MW-day)**	**(%)**	**($/MW-day)**
Base Cases	[A]	[B]	[C]: [A] × [B]	[D]	[E]: [C] + [D]	[F]	[G]: [E] - [F]	[H]	[I]: [G] / [H]
Gas CT (Dual Fuel, 20-year Life, 40% CF Limit)	$1,359[1]	15.9%	$590	$69	**$659**	$254[3]	$405	79%[3]	**$513**
Gas CC (20-year Life)	$1,442[1]	16.8%	$664	$159	**$823**	$571[3]	$252	81%[3]	**$311**
BESS 4-hr (20-year Life)	$2,082[2]	9.6% net of ITC	$547	$230	**$777**	$280[3]	$497	65%[3]	**$764**
***Sensitivities** (same assumptions as Base Case except as specified)*									
CT with 2022 OCC, 10-year Avg EAS	$1,033	15.9%	$449	$69	**$517**	$127	$390	79%	**$494**
CC with 15-year Life	$1,442	18.9%	$747	$155	**$903**	$571	$331	81%	**$409**
CC with 40% CF	$1,442	16.8%	$664	$159	**$823**	$411	$412	81%	**$509**
CC with 2022 OCC, 10-year Avg EAS	$1,222	16.8%	$563	$159	**$722**	$320	$402	81%	**$496**
Adjusted Empirical Net CONE 14/15 to 22/23	-	-	-	-	**-**	-	-	-	**$241[4]**
BESS 4-hr Without 30% ITC	$2,082	12.9%	$737	$230	**$967**	$280	$687	65%	**$1,056**
BESS 4-hr With More Cost Decline	$1,982	9.6% net of ITC	$521	$227	**$748**	$280	$468	65%	**$720**

1. Turbine costs have risen rapidly in tight market and future costs/availability are uncertain; could tighten more with supply chain limits and load growth.
2. BESS component capital costs reflect current supply glut $1,718/kW (recent quotes with 11% tariffs) or $1,810/kW (recent quotes with 21% tariffs) today which are scheduled to rise to 38% by 2026 (see slide 16) and could be raised further while ITC is also vulnerable.
3. PJM will be providing updated E&AS and ELCC values.
4. Adjusting for inflation and UCAP/ELCC yields $168/MW-day. Then adjusting for ATWACC being ~1.5% higher yields $241/MW-day UCAP. Could consider other adjustments too.

Discussion of Net CONE Uncertainties



- ***Long-run* Net CONE** is likely to be in the circled **red range**
  - **Technology**: CT may be attractive indicator if Net CONE is more stable, although CC is likely to remain more economic; economic capacity resources could eventually change with new techs and possible clean energy policies and increased need for flexibility services
  - **Costs**: Turbine costs likely to revert to LRMC (closer to past), and decrease with continued tech improvements increasing economies of scale, reducing LR CONE from today
  - **EAS**: But EAS also likely to moderate from today, bringing CC back up and closer to CT (but would have to change a lot to make CT an economic source of capacity)
  - **Overall**: Maybe above $241 "Adj Empirical" if need firm fuel and dry cool; and below $487 "CC w/2022 OCC with 10-yr avg EAS" if go to HA.03, shorter construction, and higher EAS than historical average w/excess cap; perhaps $300-350 overall
- **Cost needed for *short-term* adequacy** could be lower for uprates, demand response, and retirement delays but **could be much higher** for supplies that might be needed at scale to meet high load growth
  - Turbine supply chain is currently limited for meeting large fraction of 35 GW PJM forecast load growth to 2030 (as part of ~150 GW forecast US load growth and international demand)
  - This may necessitate BESS, which itself has more upside (loss of ITC, increased tariffs, rationalizing of supply glut) than likely decreases (further tech improvements and learning)
  - The prospect of capacity price spiking now but then declining toward LR Net CONE means year-1 reservation prices might be much higher than level-nominal values shown
  - *Hence prices might have to rise to "BESS Net CONE" or even much higher to attract enough new entry via auctions for 1-year commitments*
- **These are challenging conditions** affecting choice of VRR parameters and possibly other design elements to best support RPM objectives
  - In the short term, to signal sufficient supply, DR, uprates & net imports at reasonable prices
  - And to remain consistent with long-term framework to credibly provide reasonable compensation for merchant investment in long-lived assets when needed

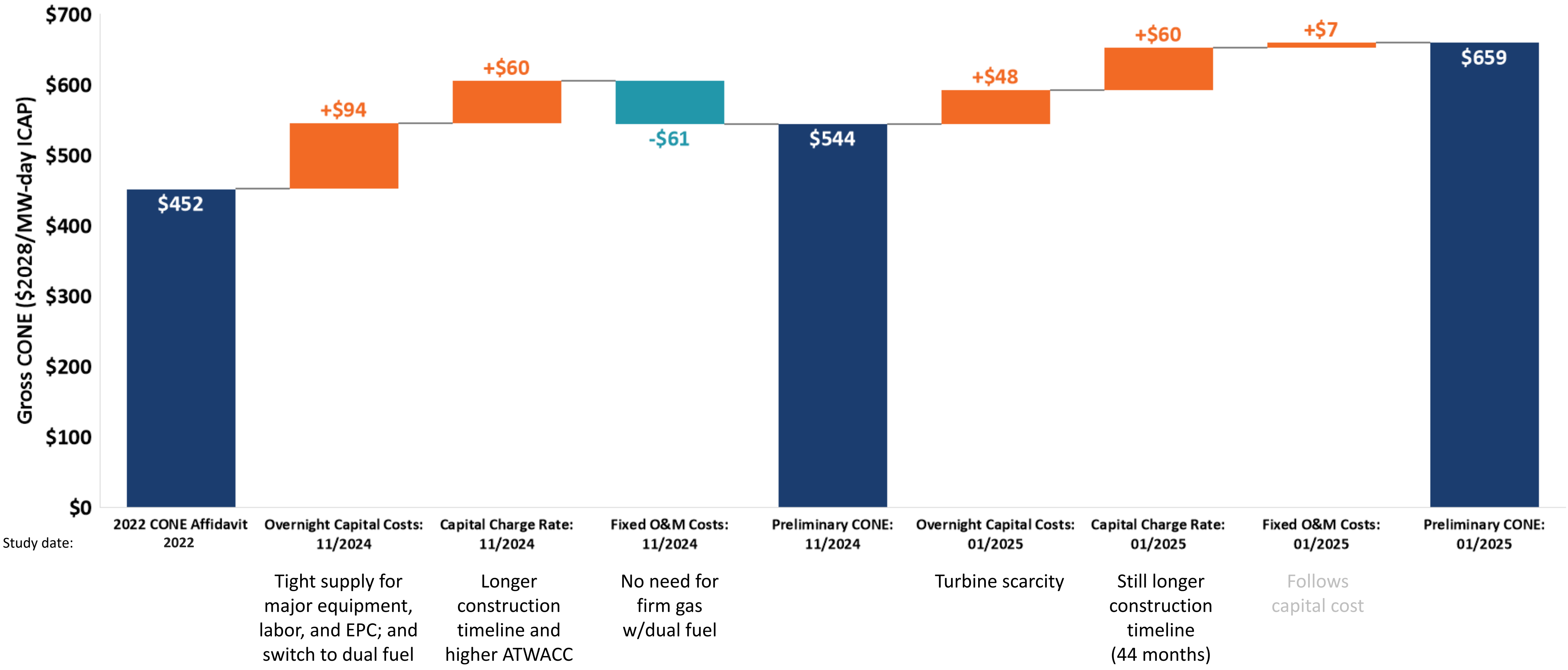
Gas-Fired CT Specifications

- **Recap:** Biggest difference from prior Quad Review is switch from firm gas to dual fuel, due to higher ELCC and no indication that dual fuel couldn't be built
- Other specifications consistent with 2022 CONE study, including locations within each previous CONE Area
- **New:** Currently developing CONE estimates for CT reference technology using **7HA.03** turbine for March 2025 final report

Characteristic	2022 Combustion Turbine	2025 Combustion Turbine
Site Type	Greenfield	Greenfield
Turbine Model	GE 7HA.02 60HZ	GE 7HA.03 60HZ
Configuration	1 x 0	1 x 0
CC Cooling System	n/a	n/a
Power Augmentation	Evaporative Cooling; no inlet chillers	Evaporative Cooling; no inlet chillers
Net Summer ICAP (MW)	361 / 363 / 353 / 350 / --*	363 / 365 / 355 / 352 / 362*
Net Heat Rate (HHV in Btu/kWh)	9320 / 9317 / 9304 / 9311 / --*	9257 / 9254 / 9241 / 9248 / 9236*
Environmental Controls	Dry Low NOx burners, SCR and CO Catalyst	Dry Low NOx burners, SCR and CO Catalyst
Fuel Supply	Firm Gas	**Dual Fuel**

Sources and Notes: *For EMAAC, SWMAAC, Rest of RTO, WMAAC, and ComEd respectively.
See also Newell et al., PJM CONE 2026/2027 Report, April 21, 2022.

Drivers of Increased CT CONE (RTO, $2028/MW-day ICAP)



Updated CT Capital Costs

- 32% **increase in turbine costs** since Nov-2024 due to market tightness for turbines
- 148% **increase in electrical interconnection costs** from Nov-2024 (previously based on 2022 escalated estimates)
- These raise costs that **apply on a percentage basis**:
  - EPC contractor fee and EPC contingency, each 10% of OFE + EPC costs
  - Owner's contingency (8% of non-EPC costs) and financing fees (4% of OFE + EPC + non-EPC costs)
- Resulting $1,340/kW current overnight costs are escalated to **overnight costs of $1,359/kW** for a June 2028 COD
  - OFE and other equipment adjusted from Jan-2025 to equipment contract lock-in date at month 5 of the 44-month construction period (i.e., escalated to Mar-2025 for a Jun-2028 COD);
  - all other costs adjusted from Jan-2025 to the midpoint of construction at month 15 of the 44-month construction period (i.e., escalated to Jan-2026 for a Jun-2028 COD)
- CONE increases further as capital charge rate increases from 14.2% to 15.9%, due to construction scheduling expanding from 36 mo to 44 mo

Capital Costs (in $millions)	Overnight Capital Costs: 11/2024	Current Overnight Capital Costs: 01/2025	Change from 11/2024
Units	Nominal$ Rest of RTO	Nominal$ Rest of RTO	Nominal$ Difference
Net Summer Capacity (MW)	355	355	
OFE+ EPC Costs	**$325**	**$370**	**$45**
Owner Furnished Equipment (OFE)			
Gas Turbines	$106	$140	$34
SCR	$45	$46	$1
Equipment, Procurement, and Construction Costs (EPC)			
Equipment			
Other Equipment	$31	$31	$0
Construction Labor	$53	$54	$1
Other Labor	$21	$21	$0
Materials	$14	$14	$0
EPC Contractor Fee	$27	$31	$4
EPC Contingency	$30	$34	$4
Non-EPC Costs	**$89**	**$106**	**$18**
Project Development	$16	$18	$2
Mobilization and Start-Up	$3	$4	$0
Non-Fuel Inventories	$2	$2	$0
Net Start-Up Fuel Costs	-$1	-$1	-$1
Electrical Interconnection	$8	$19	$11
Gas Interconnection	$33	$37	$3
Land	$0	$0	$0
Fuel Inventories	$12	$10	-$2
Owner's Contingency	$6	$7	$1
Financing Fees	$9	$10	$1
Total Overnight Capital Costs	**$413**	**$476**	**$63**
Overnight Capital Costs ($/kW)	$1,164	$1,340	$176

Note: Current costs, before adjusting for timing of a plant with a June 2028 COD. Land costs are non-zero but less than $500,000.

Updated CT O&M Costs

- **Property taxes and insurance have increased** in line with higher capital costs
- Otherwise, little change from Nov-2024 estimates
- Resulting $23.1/kW-year levelized fixed costs are escalated 41 months to the start of operation to produce $25.1/kW-year = **$69/MW-day level-nominal fixed costs** for a plant with a June 2028 COD

	O&M Costs: 11/2024	Current O&M Costs: 01/2025	Change from 11/2024
Units	Nominal$	Nominal$	Nominal$
CONE Area	Rest of RTO	Rest of RTO	Difference
Net Summer Capacity (MW)	*355*	*355*	
Fixed First Year O&M ($ million/year)			
LTSA Fixed Payments	$0.4	$0.4	$0.0
Labor	$0.7	$0.7	$0.0
Maintenance and Minor Repairs	$0.4	$0.4	$0.0
Administrative and General	$0.2	$0.2	$0.0
Asset Management	$0.4	$0.4	$0.0
Property Taxes	$2.8	$3.1	$0.3
Insurance	$2.5	$2.9	$0.4
Working Capital Financing	$0.0	$0.1	$0.1
Total Fixed First Year O&M ($ million/year)	$7.4	$8.2	$0.8
Total Fixed First Year O&M ($/kW-yr)	$20.9	$23.2	$2.3
Levelized Fixed O&M ($/kW-yr)	$21.3	$23.1	$1.8
Variable O&M			
Major Maintenance - Starts Based ($/Start)	$22,931	$29,100	$6,169
Consumables, Waste Disposal, Other VOM ($/MWh)	$1.0	$1.0	$0.0

Notes: Current costs, before adjusting for timing of a plant with a June 2028 COD. The small increase in working capital cost is tied to larger overnight costs and a higher short-term borrowing rate. The working capital financing rate has been updated from 2.19% to 4.92% due to increases in corporate bond yields since the 2022 CONE Study.

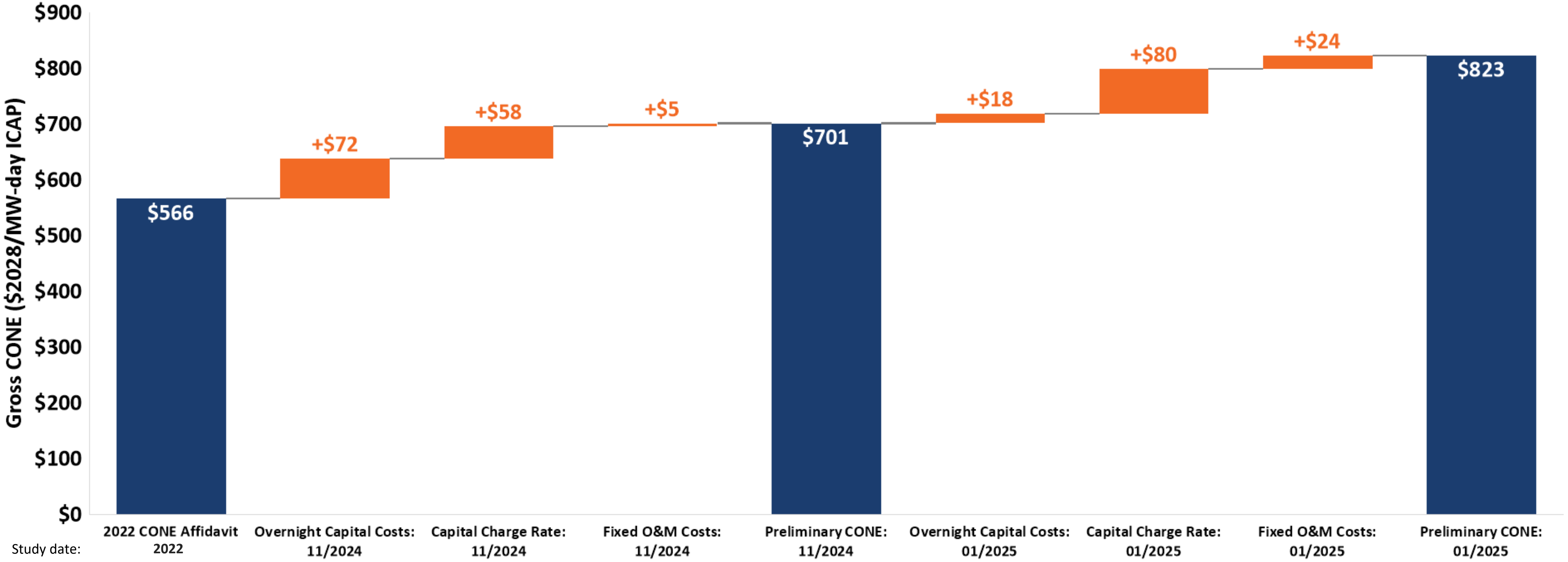
Gas-Fired CC Specifications

- **Recap:** Technical specifications and locations consistent with 2022 CONE study
- **New:** Currently developing CONE estimates for CC reference technology using **7HA.03** turbines for March 2025 final report

Characteristic	2022 Combined Cycle	2025 Combined Cycle
Site Type	Greenfield	Greenfield
Turbine Model	**GE 7HA.02 (CT), STF-A650 (ST)**	**GE 7HA.03 (CT), STF-A650 (ST)**
Configuration	2 Trains of 1 x 1 Single Shaft	2 Trains of 1 x 1 Single Shaft
CC Cooling System	Dry Air-Cooled Condenser	Dry Air-Cooled Condenser
Power Augmentation	Evaporative Cooling; no inlet chillers	Evaporative Cooling; no inlet chillers
Net Summer ICAP (MW)	Without Duct Firing: 1043 / 1047 / 1020 / 1011 / --* **With Duct Firing: 1171 / 1174 / 1144 / 1133 / --***	Without Duct Firing: 1046 / 1050 / 1023 / 1014 / 1044* **With Duct Firing: 1174 / 1177 / 1147 / 1136 / 1172***
Net Heat Rate (HHV in Btu/kWh)	Without Duct Firing: 6365 / 6383 / 6359 / 6368 / --* **With Duct Firing: 6602 / 6619 / 6593 / 6601 / --***	Without Duct Firing: 6348 / 6366 / 6342 / 6351 / 6339* **With Duct Firing: 6585 / 6602 / 6576 / 6584 / 6571***
Environmental Controls	Dry Low NOx burners, SCR and CO Catalyst	Dry Low NOx burners, SCR and CO Catalyst
Fuel Supply	Firm Gas	Firm Gas

Sources and Notes: *For EMAAC, SWMAAC, Rest of RTO, WMAAC, and ComEd respectively. See also Newell et al., PJM CONE 2026/2027 Report, April 21, 2022.

Drivers of Increased CC CONE (RTO, $2028/MW-day ICAP)



Tight supply for major equipment, labor, and EPC	Longer construction and higher ATWACC	Slightly higher firm gas costs and property taxes		Turbine scarcity	Still longer construction timeline (50 mo)	Higher firm gas costs; prop taxes and insurance follow capital cost	

Updated CC Capital Costs

- 28% **increase in turbine costs**[1] from market tightness for turbines alongside smaller increases for HRSG/SCR and steam turbines
- 2% **increase in construction labor** reflects tight market with increased competition for skilled labor
- 148% **increase in electrical interconnection costs** relative to Nov-2024 (previously based on escalated 2022 estimates)
- These raise costs that **apply on a percentage basis**
  - EPC contractor fee and EPC contingency, each 10% of OFE + EPC costs
  - Owners' contingency (8% of non-EPC costs) and financing fees (4% of OFE + EPC + non-EPC costs)
- Resulting $1,439/kW current overnight costs are escalated to **overnight costs of $1,442/kW** for a plant with a June 2028 COD
  - OFE, condenser, and other equipment adjusted from Jan-2025 to equipment contract lock-in date at month 5 of the 50-month construction period (i.e., de-escalated to Sep-2024 for a Jun-2028 COD);
  - all other costs adjusted from Jan-2025 to the midpoint of construction at month 16 of the 50-month construction period (i.e., escalated to Aug-2025 for a Jun-2028 COD)
- CONE increases further as capital charge rate increases from 14.8% to 16.8%, due to construction scheduling expanding from 40 mo to 50 mo

Capital Costs (in $millions)	Overnight Capital Costs: 11/2024	Current Overnight Capital Costs: 01/2025	Change from 11/2024
Units	Nominal$ Rest of RTO	Nominal$ Rest of RTO	Nominal$ Difference
Net Summer Capacity (MW)	*1,147*	*1,147*	
OFE + EPC Costs	$1,340	$1,433	$93
Owner Furnished Equipment (OFE)			
Gas Turbines	$210	$270	$60
HRSG / SCR	$109	$113	$3
Steam Turbines	$115	$118	$3
Equipment, Procurement, and Construction (EPC) Costs			
Equipment			
Condenser	$67	$68	$1
Other Equipment	$97	$98	$2
Construction Labor	$353	$359	$6
Other Labor	$61	$62	$1
Materials	$96	$97	$2
EPC Contractor Fee	$111	$118	$8
EPC Contingency	$122	$130	$8
Non-EPC Costs	$177	$218	$41
Project Development	$67	$72	$5
Mobilization and Start-Up	$13	$14	$1
Non-Fuel Inventories	$7	$7	$0
Emission Reduction Credits	$2	$2	$0
Net Start-Up Fuel Costs	-$14	-$20	-$7
Electrical Interconnection	$22	$54	$32
Gas Interconnection	$33	$37	$3
Land	$3	$3	$0
Owner's Contingency	$11	$13	$3
Financing Fees	$33	$36	$3
Total Overnight Capital Costs	$1,517	$1,651	$134
Overnight Capital Costs ($/kW)	$1,322	$1,439	$117

Note: Current costs, before adjusting for timing of a plant with a June 2028 COD.

1. Differs slightly from CT because of single-fuel vs. dual-fuel and an improvement in estimation methodology of single-fuel costs from quotes for dual-fuel combustion turbines.

Updated CC O&M Costs

- **Firm gas costs have increased** by 31% after having been updated from preliminary estimates (based on 2022 escalated costs) due to higher tariff rates in TCO, Michcon, and Transco Zone 5
- **Property taxes and insurance have increased** in line with higher capital costs
- Resulting current levelized fixed costs of $53.4/kW-year are escalated 41 months to the start of operation to produce $58.1/kW-year = **$159/MW-day level-nominal fixed costs** for a June 2028 COD

	O&M Costs: 11/2024	Current O&M Costs: 01/2025	Change from 11/2024
Units	Nominal$	Nominal$	Nominal$
CONE Area	**Rest of RTO**	**Rest of RTO**	**Difference**
Net Summer Capacity (MW)	*1,147*	*1,147*	
Fixed First Year O&M ($ million/year)			
LTSA Fixed Payments	$1.0	$1.0	$0.0
Labor	$3.3	$3.3	$0.0
Maintenance and Minor Repairs	$6.2	$6.2	$0.0
Administrative and General	$1.2	$1.4	$0.2
Asset Management	$1.0	$1.0	$0.0
Property Taxes	$10.9	$11.5	$0.5
Insurance	$8.9	$9.9	$1.0
Firm Gas Contract	$16.5	$21.6	$5.1
Working Capital Financing	$0.2	$0.4	$0.2
Total Fixed First Year O&M ($ million/year)	$49.2	$56.4	$7.2
Total Fixed First Year O&M ($/kW-yr)	$42.9	$49.1	$6.2
Levelized Fixed O&M ($/kW-yr)	$46.7	$53.4	$6.7
Variable O&M ($/MWh)			
Major Maintenance - Hours Based	$1.5	$1.8	$0.3
Consumables, Waste Disposal, Other VOM	$0.7	$0.7	$0.0
Total Variable O&M ($/MWh)	$2.2	$2.5	$0.3

Note: Current costs, before adjusting for timing of a plant with a June 2028 COD.

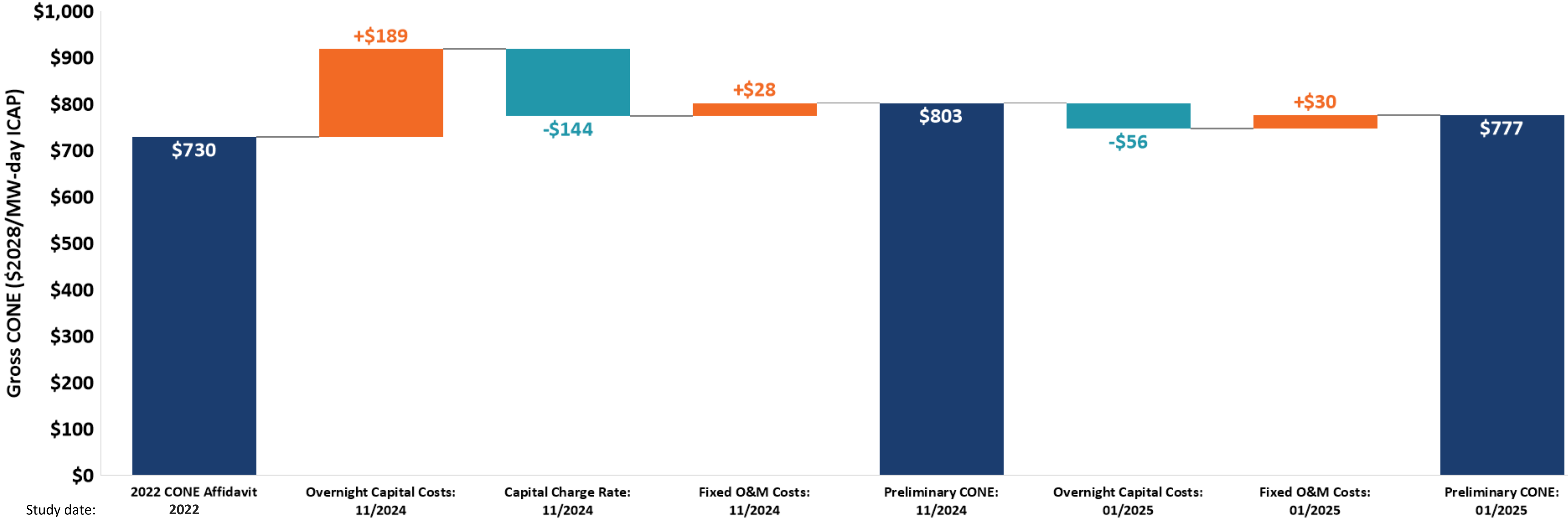
4-hr BESS Specifications

- **Recap:** Biggest difference from 2022 review is moving from a 15-year to a **20-year** economic life, based on S&L's experience with recent PPA terms and developers' financial models
- Other technical specifications and locations consistent with 2022 CONE Study
- **New:** Less overall overbuild and augmentation due to reduced capacity degradation
- Augmentations become more frequent after the first augmentation and increase in size later in the economic life to capture future real cost declines

Characteristic	2022 BESS	2025 BESS
Battery Technology	Lithium-ion	Lithium-ion
Installation Configuration	Containerized	Containerized
Rated Output Power (at POI)	200 MW-ac	200 MW-ac
Duration	4 hours	4 hours
Installed Energy Capacity	1,030 MWh-dc	**1,009 MWh-dc**
Annual Capacity Degradation	4% in Year 1, then 2% per year	**4.5% in Year 1, then 1.55% per year**
Augmentation Period	Every 5 years	**First augmentation 5 years, then every 3 years**
Use Case	Daily Cycling	Daily Cycling
Round Trip Efficiency	85%	85%
Economic Life	15 Years	**20 Years**

Sources and Notes: See also Newell et al., PJM CONE 2026/2027 Report, April 21, 2022.

Drivers of Increased BESS CONE (RTO, $2028/MW-day ICAP)



Overnight Capital Costs: 11/2024	Capital Charge Rate: 11/2024	Fixed O&M Costs: 11/2024	Overnight Capital Costs: 01/2025	Fixed O&M Costs: 01/2025
Higher BESS equipment costs and construction/ materials	Savings from ITC, partially offset by longer construction and higher ATWACC	Increase in land/prop tax and O&M contract costs	Decrease in cost of batteries and enclosures, partly offset by tariffs	Increase in O&M contract costs and tariffs

Updated BESS Capital Costs

- **Batteries and enclosures decreased** 25% relative to Nov-2024 (based on costs of projects in 2023)
- **Construction & Materials decreased** 12% and **Project Management decreased** 17% relative to Nov-2024 due to less initial overbuild (see slide 14)
- These lower costs that **apply on a percentage basis**
  - Project Development (5% of EPC costs), Mobilization and Start-up (1% of EPC costs), and Owner's Contingency (5% of BESS Equipment costs)
- 11% **increase in PCS and BOP equipment costs** relative to Nov-2024 due to tight market for transformers, breakers, and other electrical components
- 148% **increase in electrical interconnection costs** relative to Nov-2024 (previously based on escalated 2022 estimates)
- Resulting $1,810/kW current overnight costs are escalated and increases to Section 301 tariffs are applied[1] to produce **overnight costs of $2,082/kW** for a plant with a June 2028 COD
  - BESS Equipment costs adjusted from Jan-2025 to the equipment contract lock-in date at month 4 of the 20-month construction period (i.e., escalated to Feb-2027 for a Jun-2028 COD);
  - all other costs adjusted from Jan-2025 to the midpoint of construction at month 10 of the 20-month construction period (i.e., escalated to Aug-2027 for a Jun-2028 COD)

Capital Costs (in $millions)	Overnight Capital Costs: 11/2024	Current Overnight Capital Costs: 01/2025	Change from 11/2024
Units	Nominal$	Nominal$	Nominal$
CONE Area	Rest of RTO	Rest of RTO	Difference
Net Summer Capacity (MW)	*200*	*200*	
Equipment, Procurement and Construction (EPC)	$386	$316	-$70
BESS Equipment			
Batteries and Enclosures	$263	$198	-$64
PCS and BOP Equipment	$44	$48	$5
Project Management	$14	$12	-$2
Construction & Materials	$66	$58	-$8
Non-EPC Costs	$45	$46	$1
Project Development	$19	$16	-$4
Mobilization and Start-Up	$4	$3	-$1
Owner's Contingency	$15	$12	-$3
Land	$1	$1	$0
Electrical Interconnection	$4	$11	$6
Financing Fees	$2	$2	$0
Initial Working Capital	$0	$2	$2
Total Overnight Capital Costs	$431	$362	-$69
Overnight Capital Costs ($/kW)	$2,157	$1,810	-$347

Note: Current costs, before adjusting for timing of a plant with a June 2028 COD. Current Overnight Capital Costs are $1,718/kW (recent quotes with 11% tariffs) or $1,810/kW (recent quotes with 21% tariffs) today applied to Batteries and Enclosures, which are scheduled to rise to 38% by 2026.

11% current tariff includes: 7.5% §301 tariff + 3.4% general tariff;
28% current tariff includes: previous tariffs plus Feb 1, 2025 10% additional tariff from Trump Administration;
38% future tariffs includes: 25% §301 tariff + 3.4% general tariff + 10% additional tariff from Trump Administration.

Updated BESS O&M Costs

- **O&M contract costs increased** by 23% due to more robust performance guarantees and the inclusion of more maintenance activities S&L has observed in recent contracts
- **Property taxes** decreased by 18% as overnight cost reductions outweigh the effects of tariffs on assessed property value
  - Tariffs increase property taxes by increasing overnight costs and thus the plant's assessed value; but
  - Lower equipment costs reduce overnight costs and lead to a lower assessed value of personal property, decreasing personal property taxes
- Levelized augmentation costs are about the same despite lower net capital costs in 2026 and lower augmentation volume since future cost escalation follows inflation curve
- Resulting $77.2/kW-year current levelized fixed costs are escalated 41 months to the start of operation to produce $83.9/kW-year = **$230/MW-day level-nominal fixed costs** for a plant with a June 2028 COD

O&M Costs	O&M Costs: 11/2024	Current O&M Costs: 01/2025	Change from 11/2024
Units	Nominal$	Nominal$	Nominal$
CONE Area	Rest of RTO	Rest of RTO	Difference
Net Summer Capacity (MW)	*200*	*200*	
Fixed O&M ($ million)			
O&M Contract Fixed Payments	$3.5	$4.3	$0.8
BOP and Substation O&M	$0.1	$0.1	$0.0
Station Load / Aux Load	$0.4	$0.5	$0.1
Miscellaneous Owner Costs	$0.3	$0.3	$0.1
Operating Insurance	$1.7	$1.8	$0.1
Land Lease or Property Taxes	$3.9	$3.2	-$0.7
Working Capital Financing	$0.0	$0.1	$0.1
First-Year Fixed O&M ($million/year)	$9.9	$10.3	$0.4
First-Year Fixed O&M ($/kW-yr)	$49.3	$51.6	$2.2
Levelized Fixed O&M ($/kW-yr)	$50.5	$60.8	$10.4
Augmentation Costs			
Levelized Augmentation Costs ($/kW-yr)	$16.5	$16.3	-$0.2
Levelized O&M + Augmentation			
Total Levelized Fixed Costs ($/kW-yr)	$67.0	$77.2	$10.2

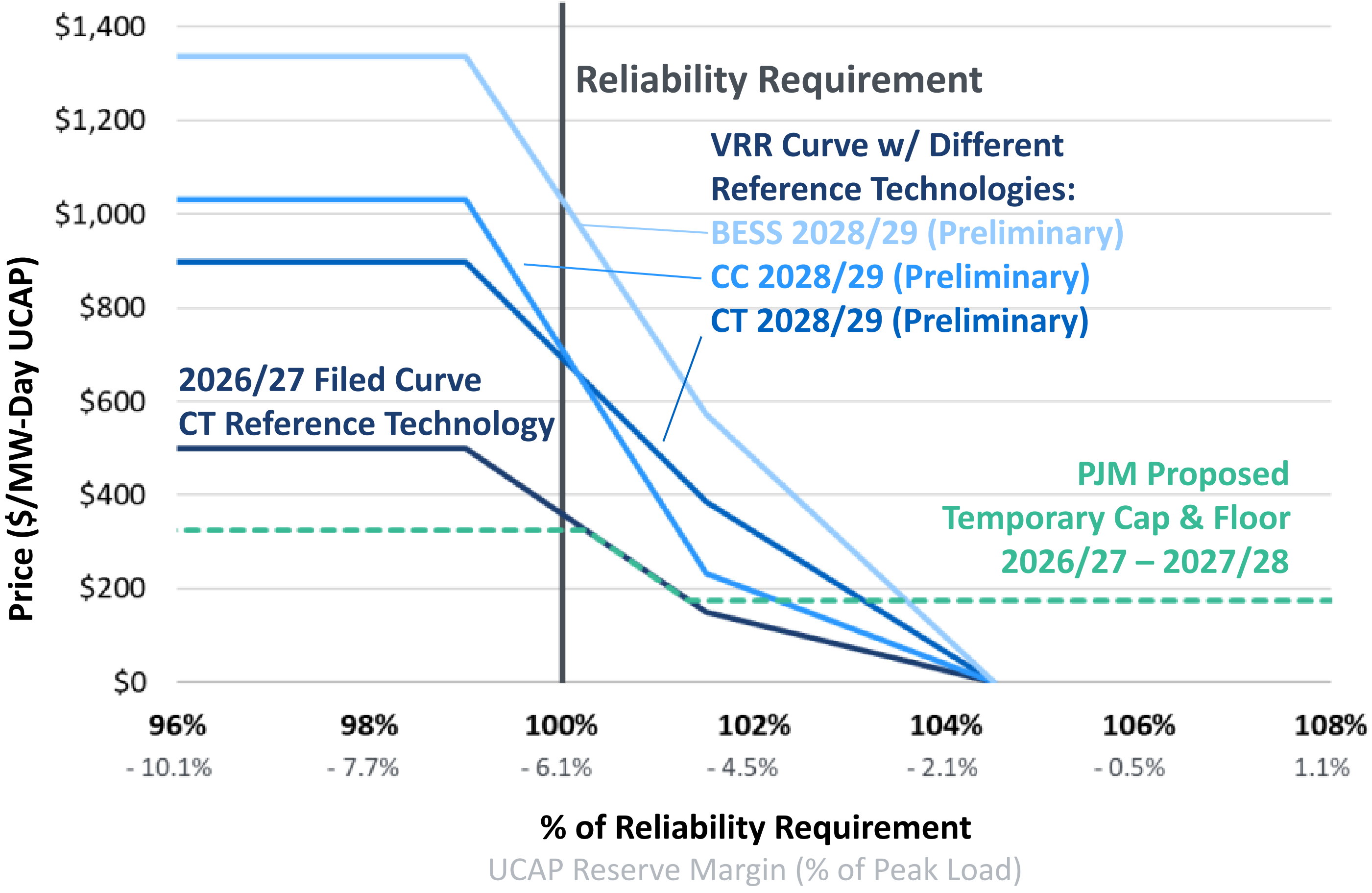
Note: Current costs, before adjusting for timing of a plant with a June 2028 COD.

1. Net CONE Updates
2. MRI Curves Tuned to 1-in-10
3. Price Cap Considerations
4. LDA Curves
5. Next Steps

Current VRR Curve Formula: Effect of Net CONE & Reference Tech

- Current VRR curve formula produces substantial variability in VRR curve price cap/height, depending on final Net CONE, Gross CONE, and Reference Technology
- Preliminary recommendation to stabilize VRR curve cap and pricing parameters over the review period. Seeking feedback on options:
  - Adopt Net CONE and price parameters, with simplified annual updates based on CPI
  - Consider range of potential technologies and uncertainties in Net CONE for setting VRR curve prices, rather than specifying specific reference technology
  - Alternatives to CONE-based minimum on cap (e.g. fixed adder above Net CONE, or stabilized price cap)
- For purposes of exploring MRI-based VRR curves, we consider:
  - Indicative Net CONE of $300/MW-day,
  - Net CONE sensitivity range of $150-$700/MW-day

Current VRR Curve, Varying Net CONE and CONE Parameters



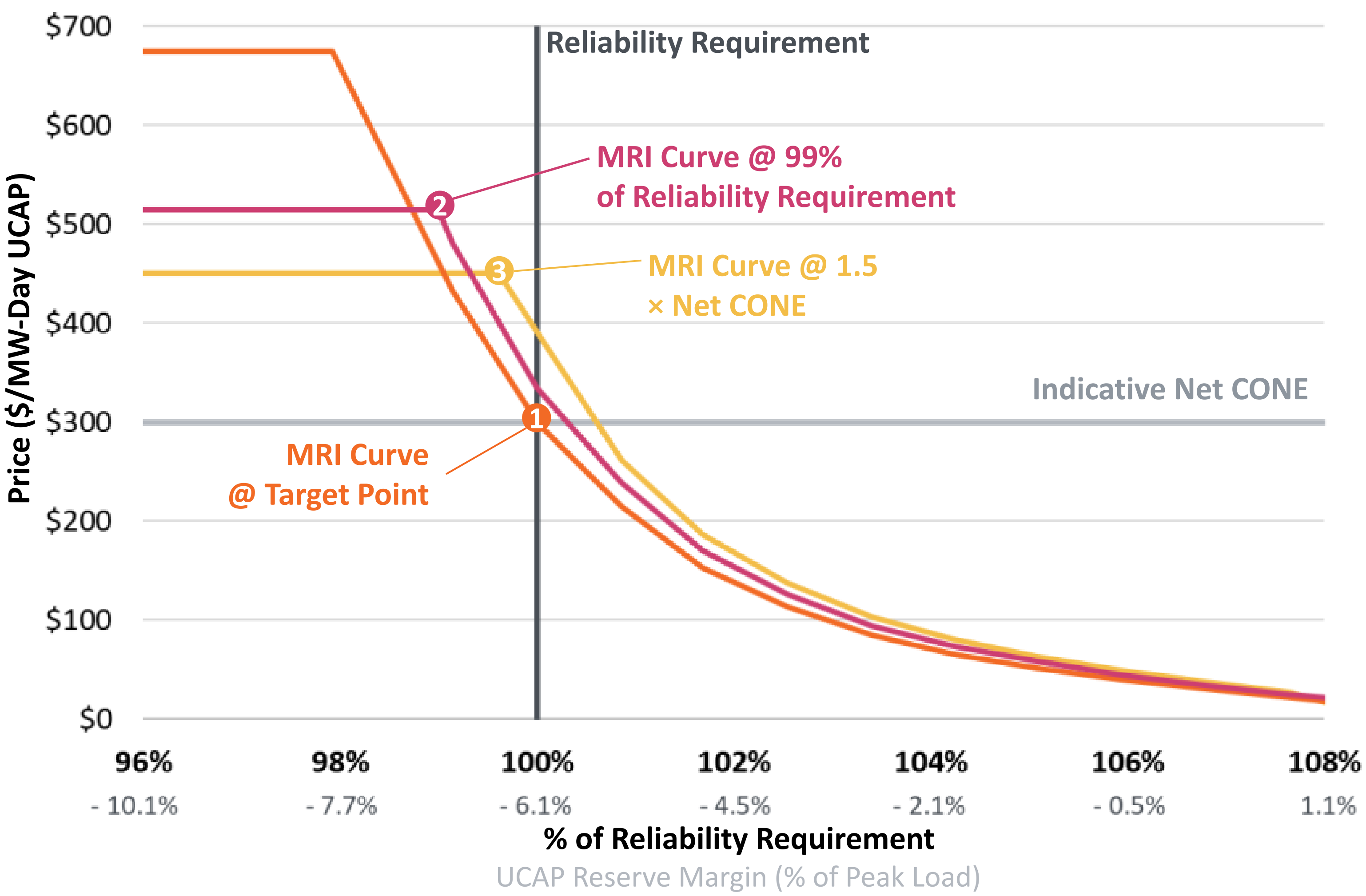
Sources and Notes: 2026/27 Filed Curve from PJM, Affidavit of Walter Graf and Skyler Marzewski on Behalf of PJM Interconnection, L.L.C., Docket No. ER25-682-000. The temporary price cap and price floor curve reflects the proposed curve for the 2026/27 and 2027/28 auctions as presented in the members committee meeting: PJM, Consultation: Capacity Market Demand Curve Adjustments Pursuant to Proposed Settlement, February 7, 2025. Brattle estimates of CC, CT, and BESS costs will be updated as Net CONE study proceeds.

MRI Curves "tuned" to 1-in-10 Reliability Standard

Considered different MRI curves defined by:

1. **Target Point:** curve through Net CONE at the Reliability Requirement, price cap P and Q adjusted to achieve 1-in-10 LOLE
2. **Cap @ 99% of Reliability Requirement:** curve through price cap Q = 99% of reliability requirement, price cap P = adjusted to achieve 1-in-10 LOLE
3. **Cap @ 1.5 × Net CONE:** curve through price cap P = 1.5 × Net CONE, Q at cap adjusted to achieve 1-in-10 LOLE

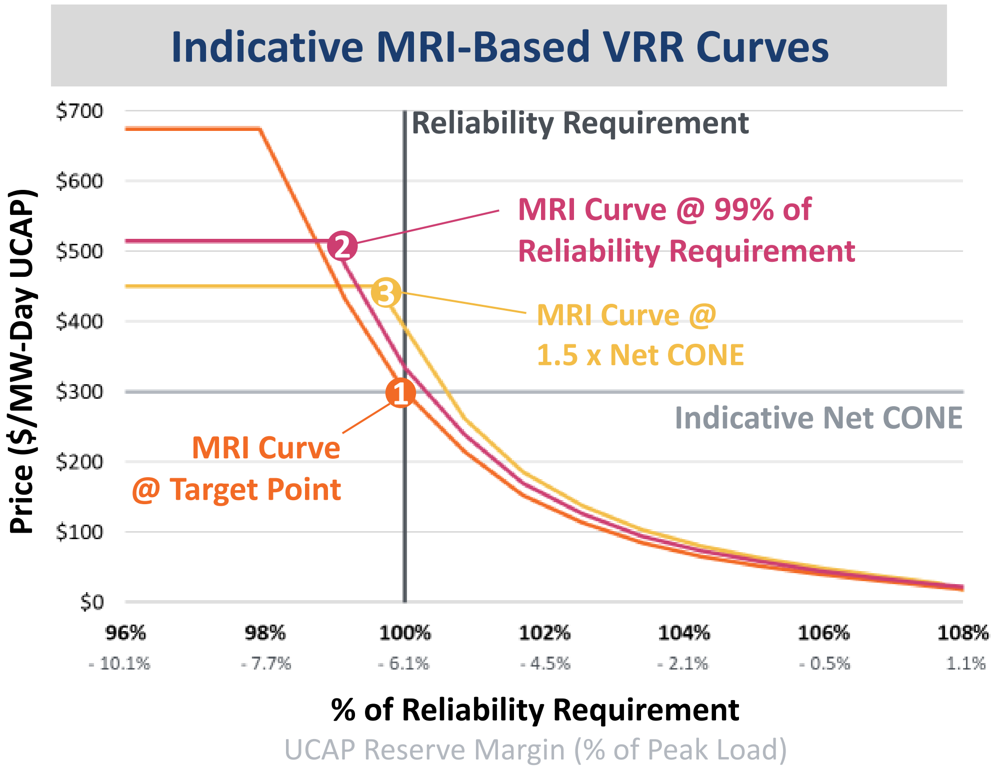
Indicative MRI-Based VRR Curves



Sources and Notes: Curves 1, 2, and 3 based on indicative Net CONE value of $300/UCAP MW-day.

Tuned MRI Curve Results

- Can maintain 0.1 LOLE while lowering price cap under base assumptions with long-term Net CONE at $300/MW-day (following slides consider sensitivity to a much larger Net CONE uncertainty range of $150-$700/MW-day)
- **Curve through Target Point:** Conceptually appealing, requires higher maximum price to compensate for lower quantities in most years. Minimum quantity at 98% of Reliability Requirement
- Cap defined by **99% of Requirement** or **1.5 × Net CONE:** by right-shifting or up-shifting the curve to improve reliability in most runs, a lower price cap can be accepted while maintaining 0.1 LOLE



	Price			Reliability							Cost
	Average Clearing Price ($/MW-d)	Standard Deviation ($/MW-d)	Frequency at Cap (%)	Average LOLE (events/yr)	Average Excess (Deficit) Above Reliability Requirement (MW)	Average Excess (Deficit) Above Target Reserve Margin (UCAP RR + X %)	Average EUE (MWh)	Normalized Portfolio EUE (% of Target) (%)	Frequency Below Reliability Requirement (%)	Frequency Below 99% of Reliability Requirement (%)	Average Procurement Cost ($ mln/yr)
1 Tuned MRI Curve Through Target	$300	$150	3.9%	0.100	379	0.29%	1,599	105.2%	37.1%	15.0%	$14,728
2 Tuned MRI Curve, Price Cap @ 99% RR	$300	$126	13.0%	0.100	494	0.38%	1,621	106.7%	33.6%	13.0%	$14,728
3 Tuned MRI Curve, Cap at 1.5 x Net CONE	$300	$111	20.9%	0.100	586	0.44%	1,661	109.3%	28.2%	15.5%	$14,728

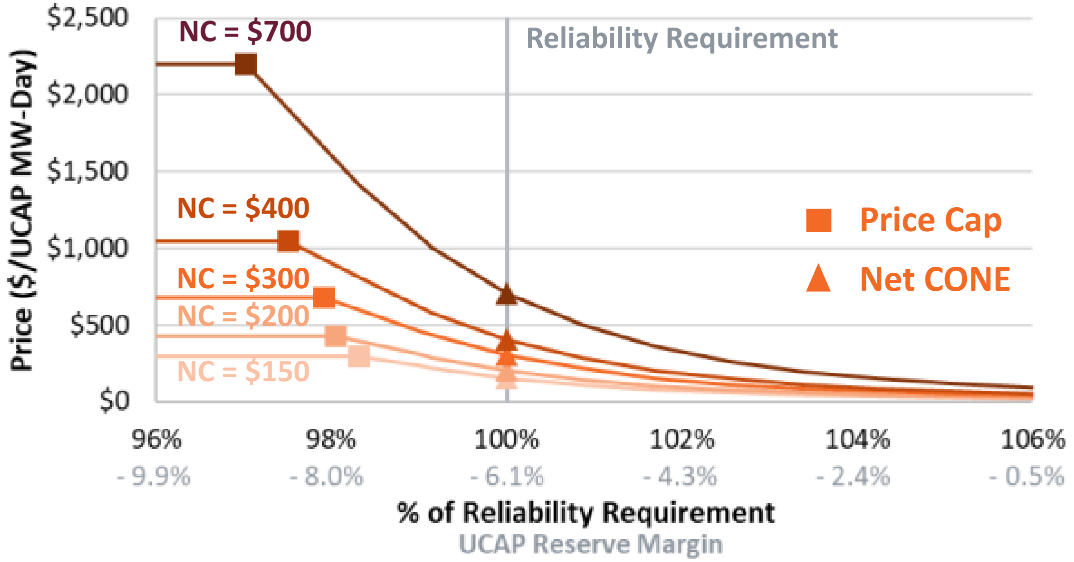
Sources and Notes: The analysis assumes a Net CONE of $300/MW-Day loosely based on indicative CC Net CONE estimates in 2028$. Values will be updated for final report.

Tuned MRI Curves, Sensitivity to Net CONE

Variations of Curve #1: MRI Curve at Target Point

- Higher Net CONE requires higher price cap to support 1-in-10 reliability standard (long-run equilibrium model conditions)
- Sensitive to low-reliability outcomes, since curve does not reach price cap until lower 97.5%-98% of Reliability Requirement
- Cap is also a higher *multiple* of Net CONE, with that multiple increasing with higher Net CONE values (range of 195%-314% of Net CONE)

MRI-Based Curves, Varying Net CONE and Caps



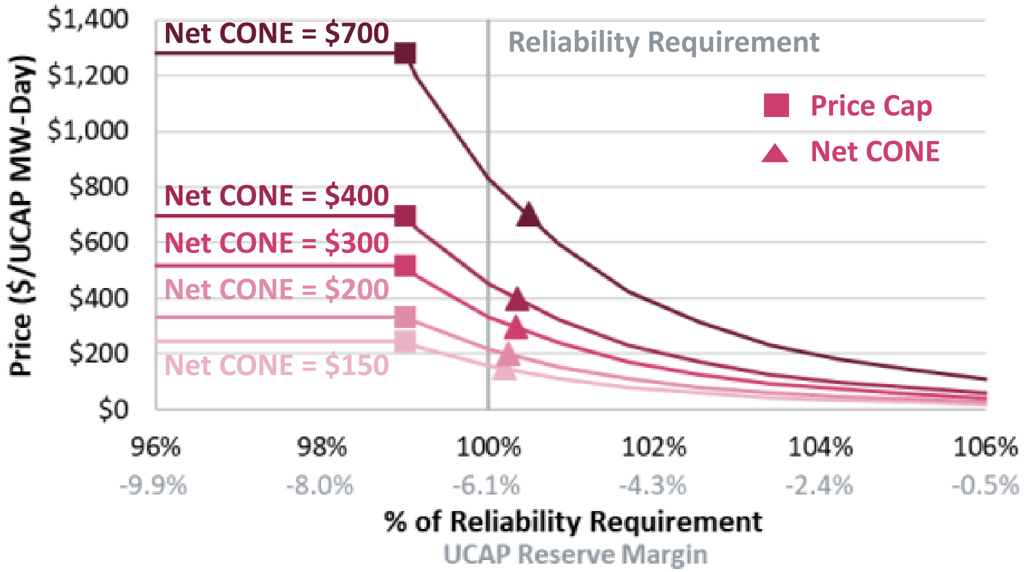
	Clearing Price			Price Cap @ 1-in-10			Reliability							Cost
	Average Clearing Price ($/MW-d)	Standard Deviation ($/MW-d)	Frequency at Cap (%)	Price ($/MW-d)	Multiple of Net CONE (%)	Adder to Net CONE ($/MW-d)	Average LOLE ($/MW-d)	Average Excess (Deficit) Above Reliability Requirement (MW)	Average Excess (Deficit) Above Target Reserve Margin (UCAP RR + X %)	Average EUE (MWh)	Normalized Portfolio EUE (% of Target) (%)	Frequency Below Reliability Requirement (%)	Frequency Below 99% of Reliability Requirement (%)	Average Procurement Cost ($ mln/yr)
Net CONE = $150	$150	$62	2.8%	$290	193%	$140	0.100	329	0.25%	1,564	102.9%	47.7%	9.4%	$7,348
Net CONE = $200	$200	$88	3.6%	$430	215%	$230	0.100	323	0.25%	1,589	104.6%	44.1%	12.6%	$9,810
Net CONE = $300	$300	$150	3.9%	$675	225%	$375	0.100	379	0.29%	1,599	105.2%	37.1%	15.0%	$14,728
Net CONE = $400	$400	$231	4.4%	$1,050	263%	$650	0.100	474	0.36%	1,619	106.5%	36.2%	14.7%	$19,646
Net CONE = $700	$700	$515	4.9%	$2,200	314%	$1,500	0.100	706	0.53%	1,664	109.5%	31.9%	18.1%	$34,403

Tuned MRI Curves, Sensitivity to Net CONE

Variations of Curve #2: Cap at 99% of Reliability Requirement

- As in all curve variations, higher Net CONE requires higher price cap to support 1-in-10 reliability standard (long-run equilibrium conditions)
- But with cap quantity fixed at 99% of Reliability Requirement, cap price required to maintain reliability remains at a relatively stable 168%-183% multiple of Net CONE
- One stakeholder-proposed option is to remove the CONE-based minimum on the price cap, but prevent VRR curve collapse by using a minimum price adder above Net CONE. Price cap with a minimum adder of $75-$150 above Net CONE may be sufficient to prevent curve collapse in the event that administrative Net CONE becomes

MRI-Based Curves, Varying Net CONE and Caps



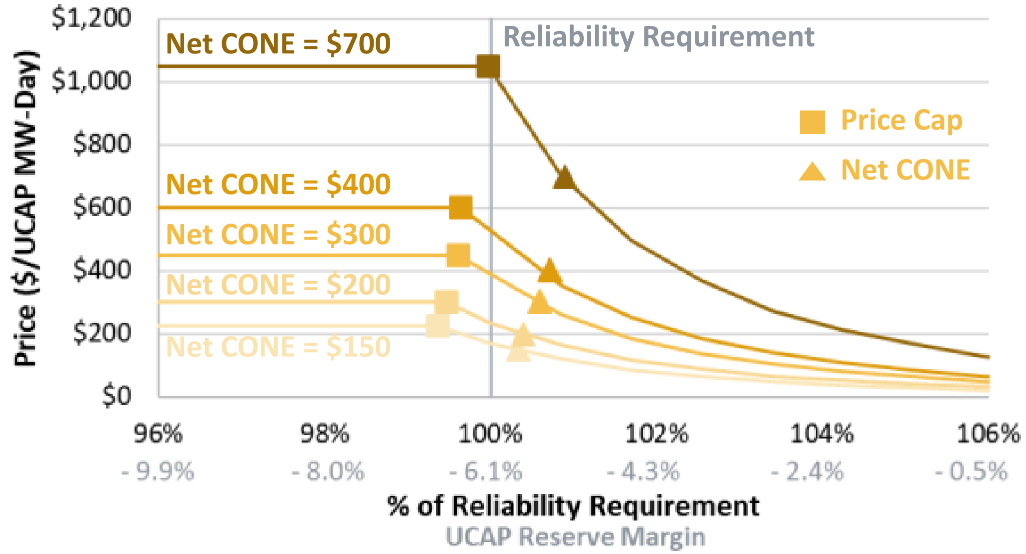
	Clearing Price			Price Cap @ 1-in-10			Reliability							Cost
	Average Clearing Price	Standard Deviation	Frequency at Cap	Price	Multiple of Net CONE	Adder to Net CONE	Average LOLE	Average Excess (Deficit) Above Reliability Requirement	Average Excess (Deficit) Above Target Reserve Margin	Average EUE	Normalized Portfolio EUE (% of Target)	Frequency Below Reliability Requirement	Frequency Below 99% of Reliability Requirement	Average Procurement Cost
	($/MW-d)	($/MW-d)	(%)	($/MW-d)	(%)	($/MW-d)	($/MW-d)	(MW)	(UCAP RR + X %)	(MWh)	(%)	(%)	(%)	($ mln/yr)
Net CONE = $150	$150	$58	7.9%	$245	163%	$95	0.100	405	0.30%	1,593	104.8%	44.2%	7.9%	$7,348
Net CONE = $200	$200	$77	11.9%	$335	168%	$135	0.100	414	0.32%	1,614	106.2%	35.6%	11.9%	$9,809
Net CONE = $300	$300	$126	13.0%	$515	172%	$215	0.100	494	0.38%	1,621	106.7%	33.6%	13.0%	$14,728
Net CONE = $400	$400	$177	14.3%	$695	174%	$295	0.100	550	0.42%	1,636	107.6%	33.5%	14.3%	$19,643
Net CONE = $700	$700	$364	17.6%	$1,280	183%	$580	0.100	783	0.59%	1,681	110.6%	32.5%	17.6%	$34,410

Tuned MRI Curves, Sensitivity to Net CONE

Variations of Curve #3: Cap at 1.5 × Net CONE

- Price cap fixed at 150% of Net CONE
- Compared to curve #2, curve #3 is moderately more right-shifted and produces lower price volatility, costs are similar
  - Right-shifting required to produce the same reliability in expectation because prices more limited on the high end. Means that population of outcomes must include more frequent price cap events for prices to equal Net CONE on average
- Much higher frequency at the price cap compared to curves #1 and #2.
- Susceptible to poor reliability outcomes if Net CONE is under-estimated (sensitivities not shown here)

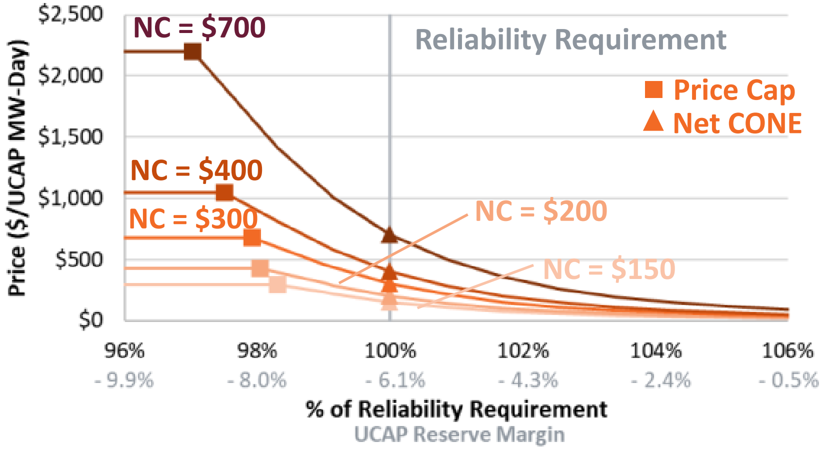
MRI-Based Curves, Varying Net CONE and Caps



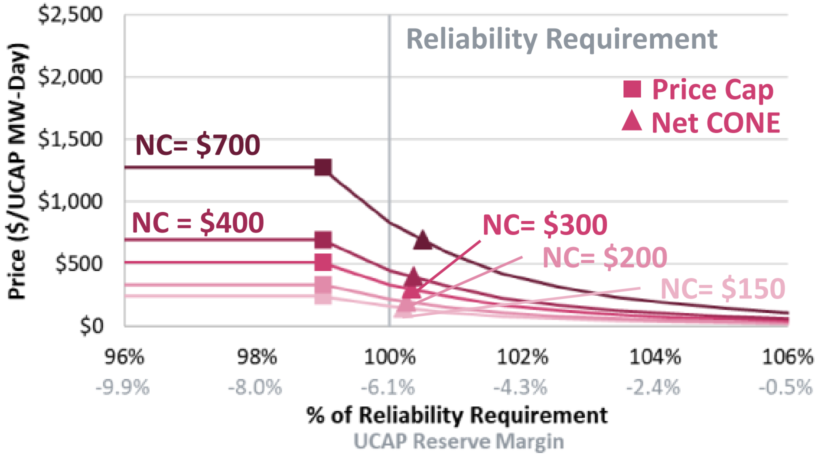
	Clearing Price			Price Cap @ 1-in-10			Reliability						Cost
	Average Clearing Price ($/MW-d)	Standard Deviation ($/MW-d)	Frequency at Cap (%)	Price ($/MW-d)	Multiple of Net CONE (%)	Adder to Net CONE ($/MW-d)	Average LOLE ($/MW-d)	Average Excess (Deficit) Above Reliability Requirement (MW)	Average Excess (Deficit) Above Target Reserve Margin (UCAP RR + X %)	Average EUE (MWh)	Normalized Portfolio EUE (% of Target) (%)	Frequency Below Reliability Requirement (%)	Frequency Below 99% of Reliability Requirement (%)	Average Procurement Cost ($ mln/yr)
Net CONE = $150	$150	$55	12.7%	$225	150%	$75	0.100	460	0.35%	1,627	107.0%	41.3%	10.2%	$7,348
Net CONE = $200	$200	$70	17.3%	$300	150%	$100	0.100	469	0.36%	1,638	107.7%	31.1%	13.6%	$9,809
Net CONE = $300	$300	$111	20.9%	$450	150%	$150	0.100	586	0.44%	1,661	109.3%	28.2%	15.5%	$14,728
Net CONE = $400	$400	$154	23.3%	$600	150%	$200	0.100	619	0.47%	1,667	109.7%	29.9%	16.3%	$19,643
Net CONE = $700	$700	$296	31.4%	$1,050	150%	$350	0.100	889	0.67%	1,702	112.0%	31.5%	19.4%	$34,414

Summary of Implications for Price Cap Given Net CONE Uncertainties

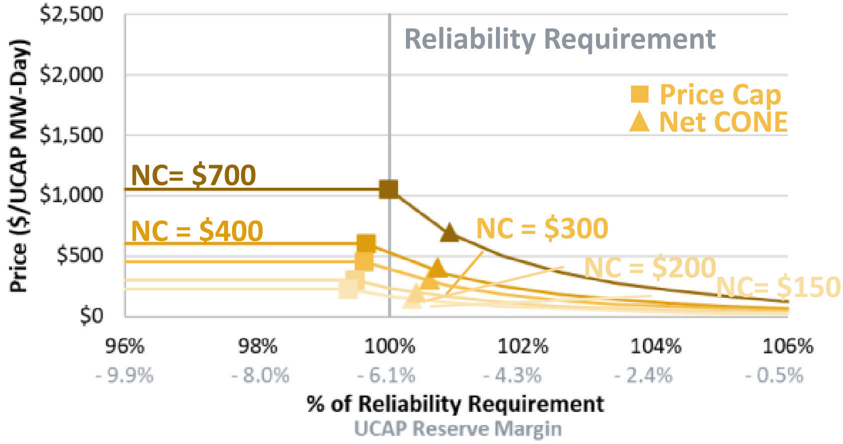
Curve #1: Anchored @ Target Point



Curve #2: Cap @ 99% of Requirement



Curve #3: Cap @ 150% of Net CONE



	Anchored to Target Point					Anchored to Cap at 99% of Reliability Requirement					Anchored to Cap at 1.5 X Net CONE				
	Price Cap			Quantities		Price Cap			Quantities		Price Cap			Quantities	
	Price	Multiple of Net CONE	Adder to Net CONE	Quantity at Price Cap	Quantity at Net CONE	Price	Multiple of Net CONE	Adder to Net CONE	Quantity at Price Cap	Quantity at Net CONE	Price	Multiple of Net CONE	Adder to Net CONE	Quantity at Price Cap	Quantity at Net CONE
	($/MW-D)	*(%)*	*($/MW-D)*	*(% of RR)*	*(% of RR)*	*($/MW-D)*	*(%)*	*($/MW-D)*	*(% of RR)*	*(% of RR)*	*($/MW-D)*	*(%)*	*($/MW-D)*	*(% of RR)*	*(% of RR)*
Net CONE = $150	$290	193%	$140	98.3%	100.0%	$245	163%	$95	99.0%	100.2%	$225	150%	$75	99.4%	100.3%
Net CONE = $200	$430	215%	$230	98.0%	100.0%	$335	168%	$135	99.0%	100.2%	$300	150%	$100	99.5%	100.4%
Net CONE = $300	$675	225%	$375	97.9%	100.0%	$515	172%	$215	99.0%	100.3%	$450	150%	$150	99.6%	100.6%
Net CONE = $400	$1,050	263%	$650	97.5%	100.0%	$695	174%	$295	99.0%	100.3%	$600	150%	$200	99.7%	100.6%
Net CONE = $700	$2,200	314%	$1,500	97.0%	100.0%	$1,280	183%	$580	99.0%	100.5%	$1,050	150%	$350	100.0%	100.8%

Curve #1: Cap is a substantially higher multiple of Net CONE compared to today. Poorer reliability before reaching cap

Curve #2: Cap @ 99% of requirement and lower value than current CONE-based minimum. Curve runs through Net CONE @ about 0.5% above Requirement

Curve #3: Lowering cap to 50% of Net CONE requires right-shifting the curve another 0.5% to maintain reliability

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Considerations When Setting Capacity Market Price Cap

Current formula for price cap:

Max [1.75 × Net CONE,
or
1 × Gross CONE]

Price cap should be high enough to:

- Attract entry over the long term sufficient to meet 1-in-10 reliability standard
- High enough to allow year-to-year variation in prices as supply-demand conditions evolve (requires a price cap that is a multiple or adder above the true Net CONE faced by developers)
- Attract short-term supply response (e.g., uprates, demand response, imports, retirement extensions)

Price cap should be limited on high side considering:

- Mitigating customers' exposure to pricing extremes
- Mitigating exposure to potential exercise of market power
- Pricing extremes driven by barriers to entry, surprise events, or other transient shortfalls that cannot be resolved in 1 auction (regardless of how high prices may rise)
- Whether and how backstop mechanisms assist in managing acute reliability challenges during price-cap events (without undermining long-term signals)

Formula and escalation approach:

- Stable enough to mitigate effects of uncertainty & variability in administrative estimates of Net & Gross CONE
- Adjusts sufficiently to keep up with major economic shifts

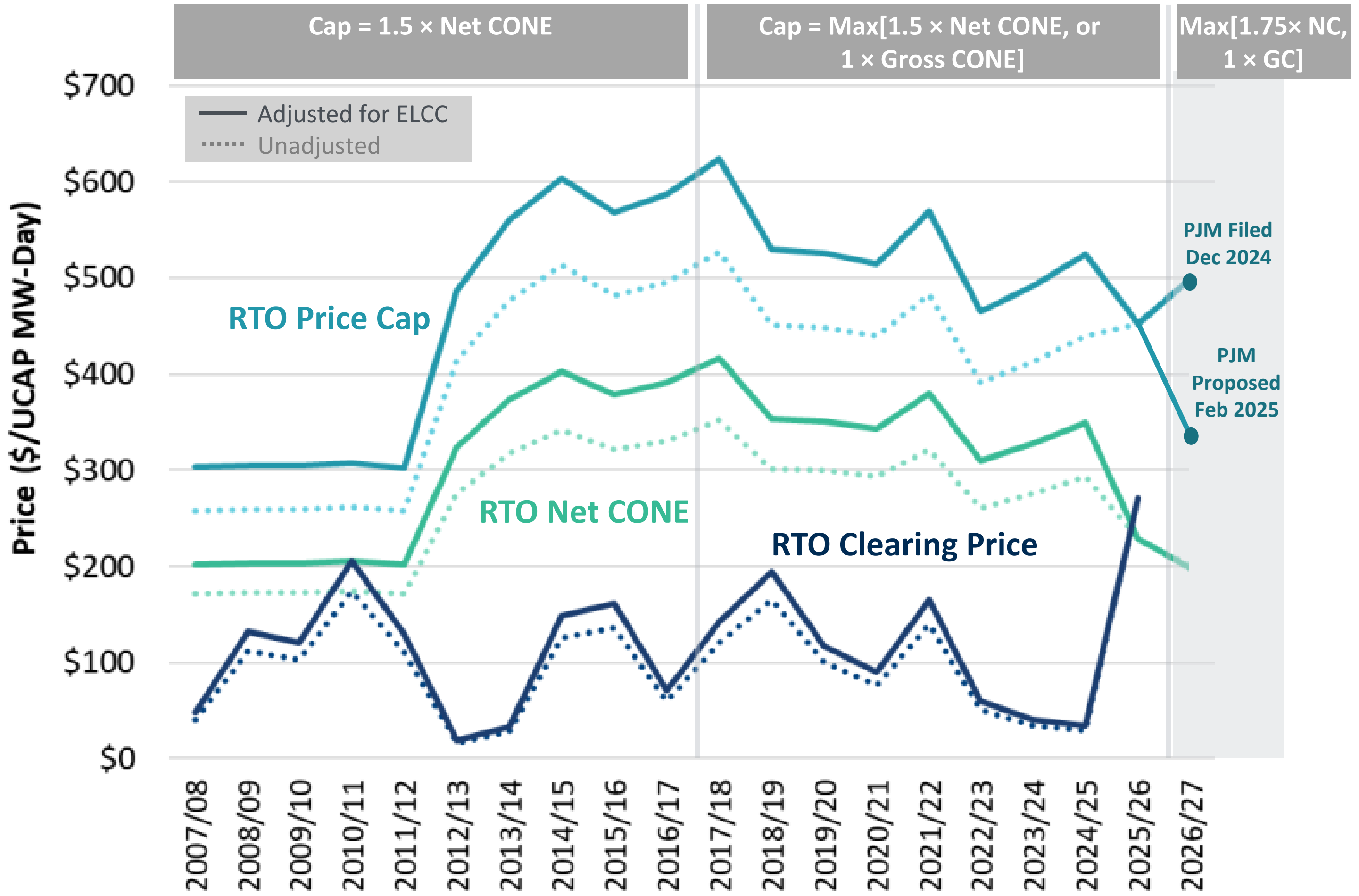
Historical Price Cap & Formula

Net CONE and reference technology presently subject to substantial uncertainty and potential for year-to-year variability in Net CONE

Seeking stakeholder input on potential adjustments to price cap formula:

- Reduce Formula for Price Cap Minimum: Based on either: (a) lower multiple of Gross CONE; or (b) minimum absolute $ adder above Net CONE. Either approach protects against VRR curve collapse if Net CONE drops to zero
- Stability in VRR Price Parameters: Set Net CONE and price cap set once for full 4-year review period (simplified annual updates escalated only based on CPI)
- Consider Multiple Possible Reference Technologies: Replace "Net CONE" parameter based on one technology with "Reference Price" that considers uncertainty over the relevant period, potentially informed by multiple technologies

Historical Price Caps, Net CONE, and Clearing Prices



Sources and notes: Nominal dollars; Historical price caps from PJM Planning Period Parameters and PJM BRA Results Reports, prices adjusted upward based on difference in Pool-Wide Accredited UCAP Factor between historical year and the 2025/26 BRA; 2026/27 values based on PJM, Affidavit of Walter Graf and Skyler Marzewski on Behalf of PJM Interconnection, L.L.C., Docket No. ER25-682-000, 2028/29 values are indicative; see PJM, Capacity Market (RPM).

Price Cap in Neighboring Capacity Markets

- Cap in PJM should consider competition for net imports with neighboring capacity markets, particularly if all regions face potential for high demand growth and tight supply
- Capacity sellers with import/export capability will opt to sell into the market with the highest expected price
- Once PJM returns to the a full 3-year forward BRA period, the region may benefit from a "first auction" advantage (e.g. risk-averse sellers may be willing to sell at a medium-to-high price in PJM, rather than wait for the possibility of a price-cap event in MISO's non-forward auction)
- Neighboring capacity markets consider seasonal capacity commitments (Currently in MISO, IESO, NYISO; Proposed in ISO-NE). Effect of price cap events is mitigated if only one season is tight. Transition to sub-annual market offers potential savings via seasonal capacity trade (e.g. if MISO remains tighter in summer, while PJM is tighter in winter)

Capacity Market Price Cap Comparison (2026$)

	Net CONE *($/MW-Day)*	CONE *($/MW-Day)*	Quantity at Price Cap *(% of Reliability Requirement)*	Price Cap Formula	Price Cap *($/MW-Day)*
PJM (Indicative)	$200	$499	99%	MAX{CONE, 1.75 x Net CONE}	$499
NYISO	$227	$417	84%	1.5 x CONE	$626
ISO-NE	$312	$489	98%	MAX{CONE, 1.6 x Net CONE}	$500
MISO*	$219	$350	99%	4 x CONE (Applied seasonally)	$1,399
IESO	$336	*n.d.*	98%	1.5 x Net CONE	$504

Sources and Notes: All prices in 2026$/UCAP MW-day, calculated by adjusting most recent parameter year available for other markets by annual inflation and using neighboring markets' UCAP ratings (which could result in higher UCAP MW quantity ratings than PJM's updated accreditation methodology); PJM Net CONE and CONE estimates are from PJM, Affidavit of Walter Graf and Skyler Marzewski on Behalf of PJM Interconnection, L.L.C., Docket No. ER25-682-000. *MISO cap is based on 4x CONE, but applied seasonally (i.e. to produce a 4x CONE cap on an annual basis, all four seasons would need to clear at the price cap).

Considerations Informing Price Cap

Consideration	Range	Suggests Price Cap:
Historical PJM Price Cap	\$500-\$550	• Historical price cap range has been sufficient to maintain supply-side interest in new developments (except in the most recent auction, but other factors at play)
Proposed Temporary Cap	\$325	• Negotiated proposal to temporarily reduce price cap & mitigate customer exposure to price-cap events under near-term tight supply conditions. Paired with price floor at \$175 to maintain supply interest
Neighboring Markets' Caps	\$500-\$626	• Price high enough to align with price caps in neighboring capacity markets and compete for imports when both regions are tight
Simulation Modeling	168%-183% of Net CONE	• Cap in that range supports 0.1 LOLE with MRI Curve #2, but challenge introduced by present uncertainty range of Net CONE
Reference Technology	\$410-\$865	• **CC Reference Tech:** Price cap of approximately \$410-\$865/MW-day may be sufficient if CC is reference technology (considering range of updated CC Net CONE estimates and price cap of 1.7 × Net CONE based on price cap multipliers from MRI Curve #2) • Higher price cap of approximately \$872 or \$1,299 if CT or BESS is reference technology (considering updated estimates of Net CONE and a price cap of 1.7 × Net CONE)
Acute or Transient Supply Shortages	Seeking stakeholder input	• If persistent barriers to entry exist, solution is to address market barriers (cannot solved by changes in the price cap) • Transient supply or turbine shortages may require higher-cost new supply until shortages resolve. For example, prices high enough to attract BESS, or multi-year commitment term if the price cap is still not high enough to attract new entry • Current rules trigger review of pricing parameters if BRA clears below 99% of requirement, is that sufficient protection against low-reliability outcomes?

Acute Reliability Risks: Role of Reliability Backstop

Role of Price Cap vs. Reliability Backstops

- A well-functioning capacity market ideally produces few events at the price cap and rarely or never relies on a reliability backstop
- However, it is difficult to set a price cap for a single-year commitment high enough to procure sufficient capacity in *all* conceivable conditions
- To mitigate risks posed by acute and transient tight supply conditions, a backstop may be needed, but the current RPM backstop can be improved to be more systematic, competitive and limit impacts on the broader market

Current RPM Backstop Mechanism:

- **<99% Reliability Requirement (1 Year):** Triggers investigation to review reasons for shortfall to recommend changes to address shortfall (e.g. address barriers to entry, increase VRR curve prices)
- **<99% Reliability Requirement (3 Consecutive Years):** Triggers post-BRA backstop auction (up to 15-year commitments, seller offers collected for 6-month bid window, sellers compete on price)
- Backstop mechanisms apply only on an RTO-wide basis (not to individual LDAs)

Potential Enhancements to Reliability Backstop Mechanism

- **Timing of Backstop Procurement:** Update timing of backstop auction to be automatically triggered if BRA auction clears short, to avoid delay in attracting supply
- **Procurement Trigger and Volume:** Backstop procurement triggered to restore cleared volume up to minimum acceptable levels: 99% RTO wide, and volume at cap for LDAs (95-99% of Requirement)
- **Term:** If one year at price cap is insufficient to attract supply, procure incremental supply at or above the price cap, but under a multi-year commitment (ranging from 2- to 15-year terms)
- **Format of competitive procurement**:
  - At or below the price cap: sellers compete on price (lowest-price offers clear for 1-year commitments), as usual
  - Backstop at or above the cap: sellers compete on term up to 15 years (shortest term wins)*
- **Sellers eligible for multi-year commitments**: New resources, plus existing resources with demonstrated cost consistent with the price cap & offered term
- **Other sellers**: Earn 1-year commitment @ price cap (same as today)
- **Applicability to LDAs:** Apply investigation & backstop triggers for both RTO-wide and LDA-specific shortfall events (e.g. LDA-specific investigation may identify localized barriers to entry or supply cost issues)

*Details of procurement format would need to be refined to incentivize sellers to offer at the lowest price and/or term they are willing to accept, and address the possibility that the price cap and term together remain insufficient to attract offers.

Current Backstop Provisions: PJM Tariff Attachment DD.16.

1 Net CONE Updates

2 MRI Curves Tuned to 1-in-10

3 Price Cap Considerations

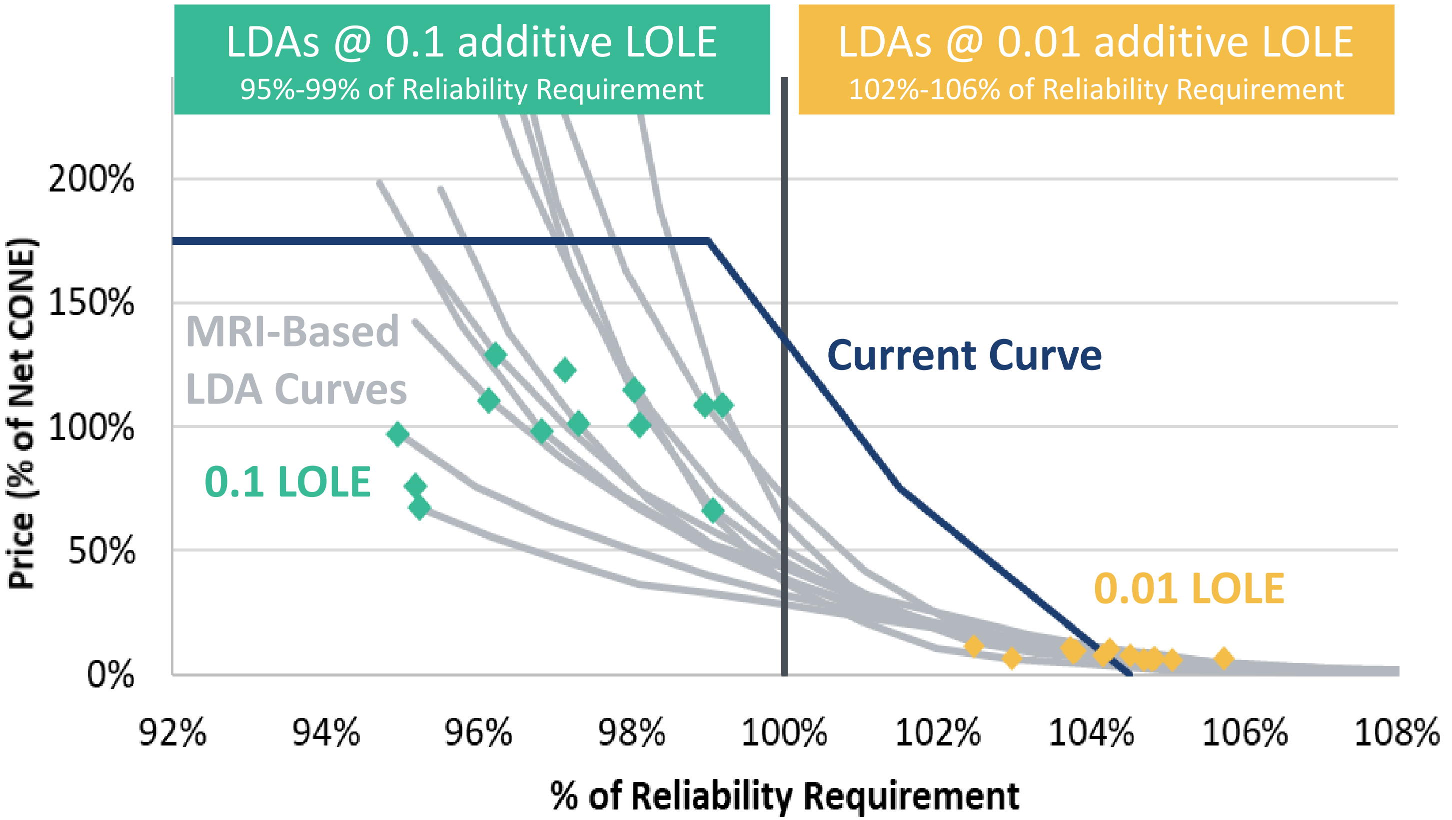
4 LDA Curves

5 Next Steps

Adapting MRI Curves to LDA: Additive MRI-based VRR Curves

- One option for deriving LDA curves would be to adapt from ISO-NE approach:
  - Single $/MWh "scaling factor" for system and LDA curves
  - Conceptual appeal is that a uniform value of reliability is applied throughout the footprint
  - LDA prices would be treated as *price adders* on top of system-wide prices (reflecting additional reliability value of locating supply in import pockets)
- Flatter shape of MRI-based curves would improve pricing stability and signal tight supply conditions sooner and more gradually
- Poor reliability of 0.1 LOLE (on top of parent & system reliability) does not occur until 95-99% of reliability requirement. Indicates that lower quantities may be acceptable before reaching price cap
- Curves appear lower and left-shifted compared to current curve, but total price on day 1 might be higher or lower than current curves depending supply-demand balance
- To implement this approach, PJM would need to update auction clearing approach to account for additive pricing and reliability value. May require a phased implementation (naturally coordinates with transition to sub-annual RPM design)

Indicative "Additive" MRI-Based LDA Curves
Uniform Scaling Factor Adopted from System-Wide Curve

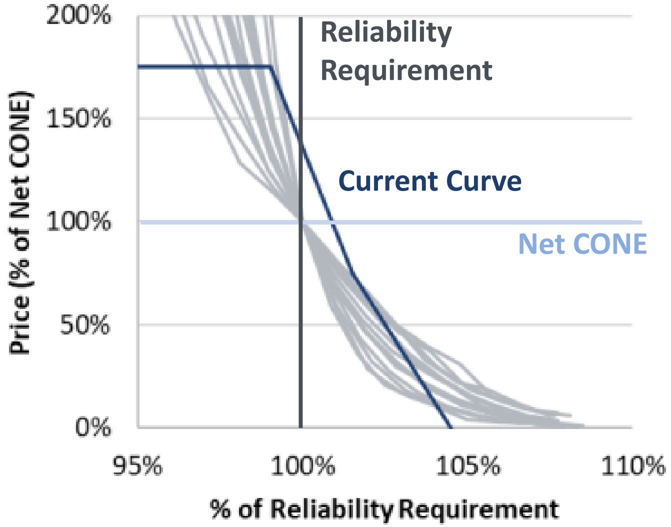


Notes: Assumes a Net CONE of $300/MW-Day. The MRI curves are constructed based on a price cap of $515/MW-Day intersection with 99% of the reliability requirement. The Current Curve assumes a Net CONE of $300/MW-Day and a binding price cap set at $525/MW-Day.

Non-Additive LDA MRI Curves: Indicative Options

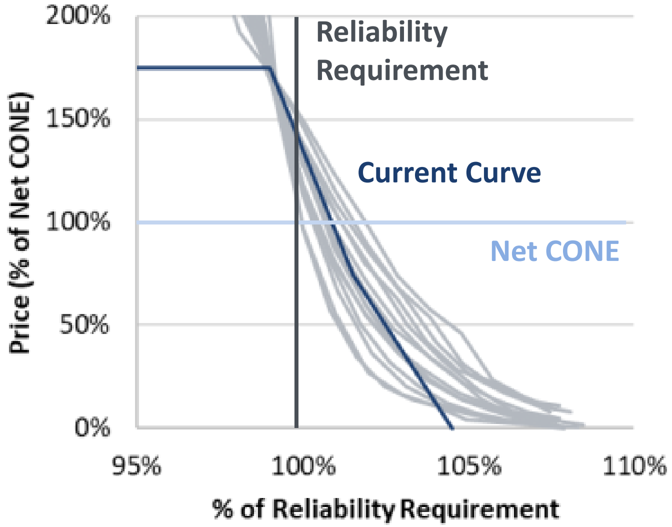
We are initially considering 3-different concepts for non-additive MRI curves for each LDA. These options would maintain current PJM auction clearing mechanics, but apply different scaling factors by LDA

LDA Option 1: LDA Curves Through the Reliability Requirement and Net CONE



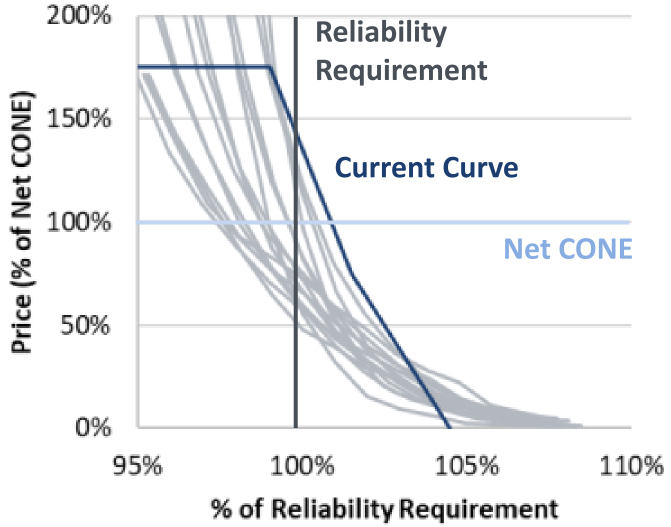
- Curve is flatter than current VRR curve (on both high and low ends)
- Lowest reliability still above 0.1 additive LOLE even though price cap events occur at lower percentage of reliability requirement
- **Preliminary recommended approach**, until auction clearing can be updated for uniform scaling factor (see prior slide)

LDA Option 2: LDA Curves Through 99% of the Reliability Requirement @ the Price Cap



- Most LDA curves right-shifted compared to current VRR curve
- Cap tied to 99% less grounded in economics on LDA basis (does not necessarily map to similar reliability levels)

LDA Option 3: LDA Curves Through 0.1 LOLE @ the Price Cap



- Price cap in range of 95-99% of reliability requirement
- Pricing below levels needed to attract supply at reliability requirement

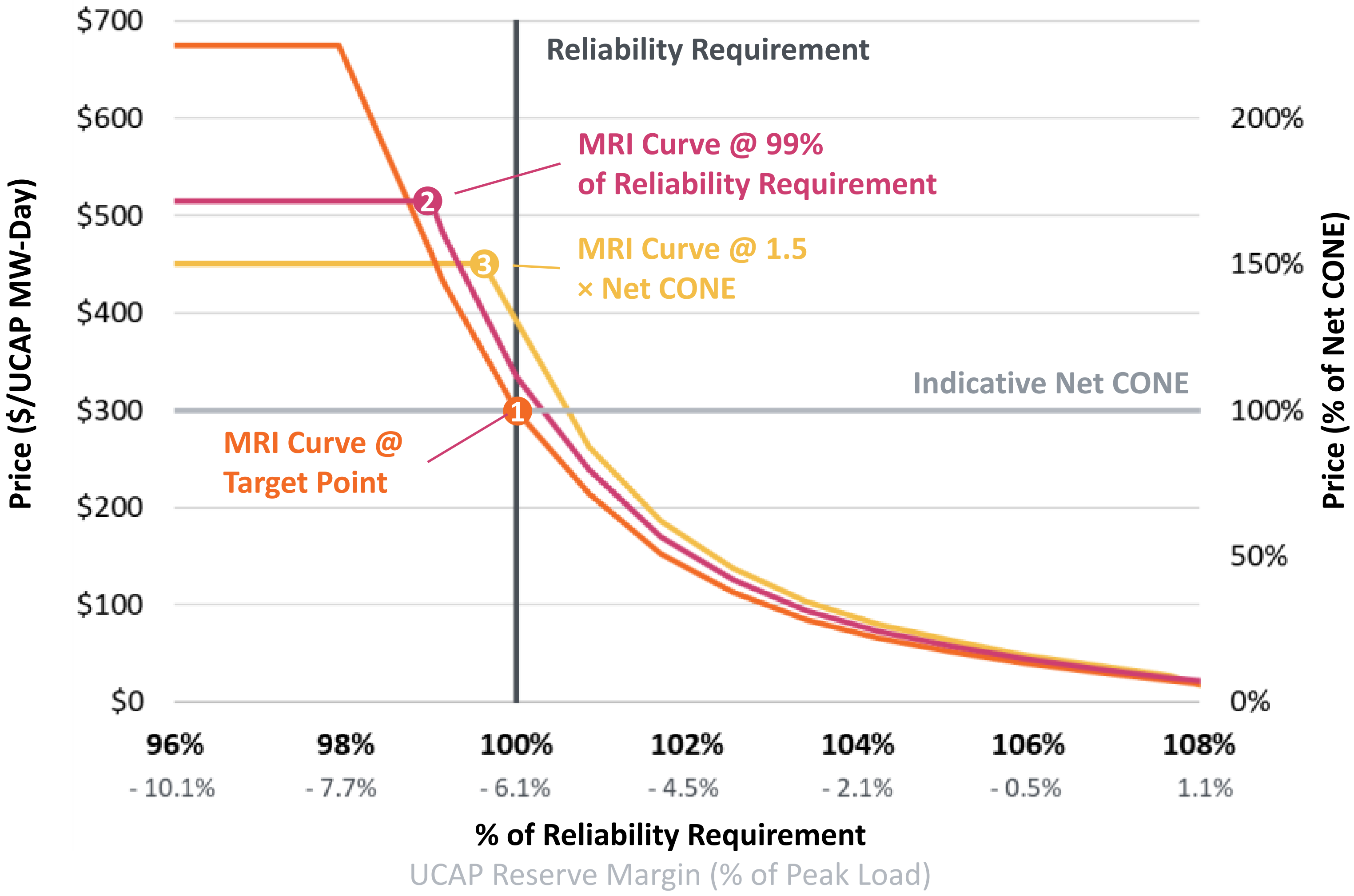
1. Net CONE Updates
2. MRI Curves Tuned to 1-in-10
3. Price Cap Considerations
4. LDA Curves
5. Next Steps

Discussion & Next Steps

Seeking stakeholder input on preliminary recommendations:

- **MRI-based curve:** leaning to Curve #2, with price cap @ 99% of Requirement and ~170% of Net CONE (Curve #3 also a reasonable balance of tradeoffs, but greater reliance on price cap events to attract supply entry)
- **Annual Updates**: Once price cap and Net CONE or “Reference Price” are selected, use simplified CPI-based annual updates to mitigate year-to-year variability in Net CONE
- **Price Cap:** Potentially $450-550/MW-day, in the range of neighboring markets’ caps and consistent with long-run pricing to attract CC-based Net CONE (still not high enough to support BESS or CT as the primary reference technology)
- **Enhanced Backstop Mechanism:** To manage risk of acute & transient shortages, introduce backstop mechanism to procure incremental supply under multi-year terms (compete on price up to the cap, incremental supply competes on term at the cap)

Indicative MRI-Based VRR Curves



Sources and Notes: Curves 1, 2, and 3 based on indicative Net CONE value of $300/UCAP MW-day.

Appendix: Tuned MRI Curve Detail

Tuned MRI Curves: Performance with Varying Net CONE

Curve 1:
Curves tuned to Net CONE and Reliability Requirement

	Clearing Price			Price Cap @ 1-in-10			Reliability							Cost
	Average Clearing Price ($/MW-d)	Standard Deviation ($/MW-d)	Frequency at Cap (%)	Price ($/MW-d)	Multiple of Net CONE (%)	Adder to Net CONE ($/MW-d)	Average LOLE ($/MW-d)	Average Excess (Deficit) Above Reliability Requirement (MW)	Average Excess (Deficit) Above Target Reserve Margin (UCAP RR + X %)	Average EUE (MWh)	Normalized Portfolio EUE (% of Target) (%)	Frequency Below Reliability Requirement (%)	Frequency Below 99% of Reliability Requirement (%)	Average Procurement Cost ($ mln/yr)
Net CONE = $150	$150	$62	2.8%	$290	193%	$140	0.100	329	0.25%	1,564	102.9%	47.7%	9.4%	$7,348
Net CONE = $200	$200	$88	3.6%	$430	215%	$230	0.100	323	0.25%	1,589	104.6%	44.1%	12.6%	$9,810
Net CONE = $300	$300	$150	3.9%	$675	225%	$375	0.100	379	0.29%	1,599	105.2%	37.1%	15.0%	$14,728
Net CONE = $400	$400	$231	4.4%	$1,050	263%	$650	0.100	474	0.36%	1,619	106.5%	36.2%	14.7%	$19,646
Net CONE = $700	$700	$515	4.9%	$2,200	314%	$1,500	0.100	706	0.53%	1,664	109.5%	31.9%	18.1%	$34,403

Curve 2:
Curves tuned to Price Cap and 99% of Reliability Requirement

	Clearing Price			Price Cap @ 1-in-10			Reliability							Cost
	Average Clearing Price ($/MW-d)	Standard Deviation ($/MW-d)	Frequency at Cap (%)	Price ($/MW-d)	Multiple of Net CONE (%)	Adder to Net CONE ($/MW-d)	Average LOLE ($/MW-d)	Average Excess (Deficit) Above Reliability Requirement (MW)	Average Excess (Deficit) Above Target Reserve Margin (UCAP RR + X %)	Average EUE (MWh)	Normalized Portfolio EUE (% of Target) (%)	Frequency Below Reliability Requirement (%)	Frequency Below 99% of Reliability Requirement (%)	Average Procurement Cost ($ mln/yr)
Net CONE = $150	$150	$58	7.9%	$245	163%	$95	0.100	405	0.30%	1,593	104.8%	44.2%	7.9%	$7,348
Net CONE = $200	$200	$77	11.9%	$335	168%	$135	0.100	414	0.32%	1,614	106.2%	35.6%	11.9%	$9,809
Net CONE = $300	$300	$126	13.0%	$515	172%	$215	0.100	494	0.38%	1,621	106.7%	33.6%	13.0%	$14,728
Net CONE = $400	$400	$177	14.3%	$695	174%	$295	0.100	550	0.42%	1,636	107.6%	33.5%	14.3%	$19,643
Net CONE = $700	$700	$364	17.6%	$1,280	183%	$580	0.100	783	0.59%	1,681	110.6%	32.5%	17.6%	$34,410

Curve 3:
Curves tuned to Price Cap and 1.5 × Net CONE

	Clearing Price			Price Cap @ 1-in-10			Reliability							Cost
	Average Clearing Price ($/MW-d)	Standard Deviation ($/MW-d)	Frequency at Cap (%)	Price ($/MW-d)	Multiple of Net CONE (%)	Adder to Net CONE ($/MW-d)	Average LOLE ($/MW-d)	Average Excess (Deficit) Above Reliability Requirement (MW)	Average Excess (Deficit) Above Target Reserve Margin (UCAP RR + X %)	Average EUE (MWh)	Normalized Portfolio EUE (% of Target) (%)	Frequency Below Reliability Requirement (%)	Frequency Below 99% of Reliability Requirement (%)	Average Procurement Cost ($ mln/yr)
Net CONE = $150	$150	$55	12.7%	$225	150%	$75	0.100	460	0.35%	1,627	107.0%	41.3%	10.2%	$7,348
Net CONE = $200	$200	$70	17.3%	$300	150%	$100	0.100	469	0.36%	1,638	107.7%	31.1%	13.6%	$9,809
Net CONE = $300	$300	$111	20.9%	$450	150%	$150	0.100	586	0.44%	1,661	109.3%	28.2%	15.5%	$14,728
Net CONE = $400	$400	$154	23.3%	$600	150%	$200	0.100	619	0.47%	1,667	109.7%	29.9%	16.3%	$19,643
Net CONE = $700	$700	$296	31.4%	$1,050	150%	$350	0.100	889	0.67%	1,702	112.0%	31.5%	19.4%	$34,414

Contact Information

Dr. Sam Newell

PRINCIPAL | BOSTON

Sam.Newell@brattle.com

+1 (781) 801-2652

Dr. Kathleen Spees

PRINCIPAL | WASHINGTON DC

Kathleen.Spees@brattle.com

+1 (412) 445-2694

Dr. Andrew W. Thompson

ENERGY ASSOCIATE | BOSTON/MADRID

Andrew.Thompson@brattle.com

+34 666 639 197