Future Market Design for Resource Adequacy

Estimating Capacity Performance Risk in PJM

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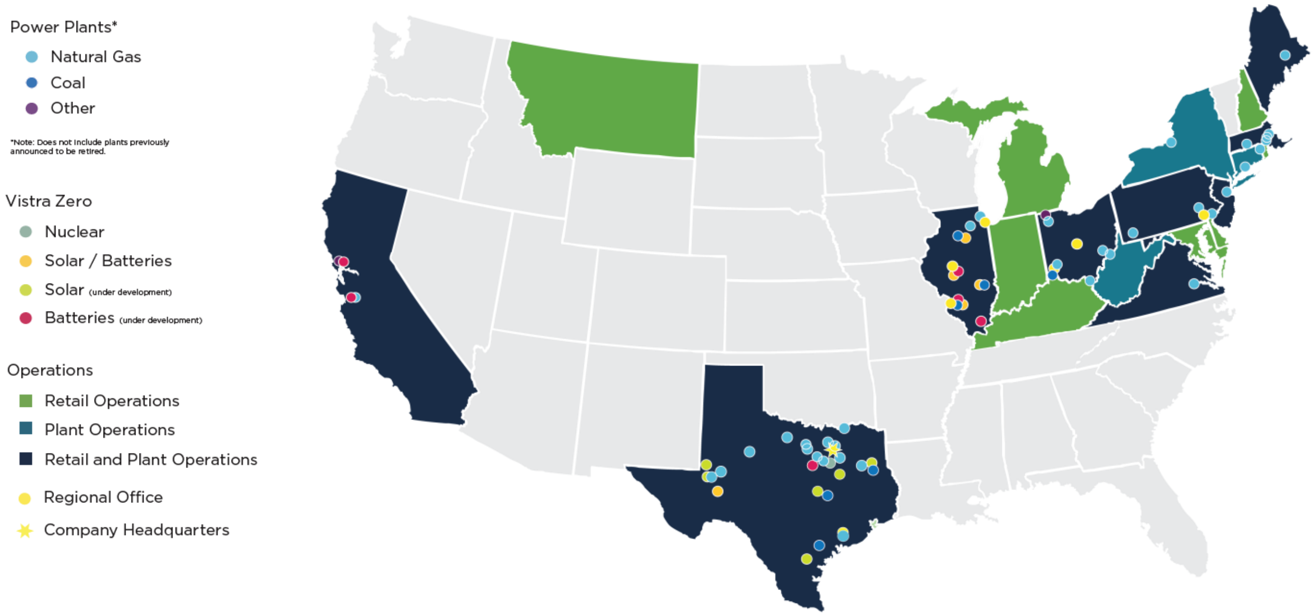
America's leading integrated energy company

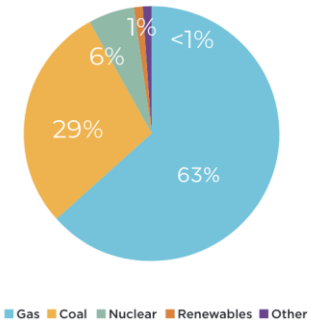
Vistra (NYSE: VST) is a leading Fortune 500 integrated retail electricity and power generation company based in Irving, Texas, providing essential resources for customers, commerce, and communities. Vistra combines an innovative, customer-centric approach to retail with safe, reliable, diverse, and efficient power generation. Vistra is the largest competitive power generator in the U.S. with a capacity of approximately 39,000 megawatts powered by a diverse portfolio of natural gas, nuclear, solar, and battery energy storage facilities, including the largest energy storage facility in the world. Vistra's retail business serves approximately 4 million residential, commercial, and industrial retail customers with electricity and natural gas, making it one of the largest competitive electricity providers in the country and offering over 50 renewable energy plans.



~39 GWs Capacity

~174 TWh Generated

Generation by Capacity



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The contents of this presentation do not reflect any commercial or strategic positions of Vistra Corp and are only intended to support discussion around PJM’s market design and evaluation of methods to capture future performance risk on the system

Background on Capacity Performance

- **PJM's Capacity Performance Construct** was introduced after the **2014 Winter Polar Vortex** on **Jan. 6 – 8** followed by a winter storm event **Jan. 19-27**
  - PJM experienced significant scheduling issues for natural gas resulting in forced outages, but also higher than average forced outages for coal, nuclear and oil. The overall system-wide forced outage rate was 2 to 3x the normal winter level
  - During the Polar Vortex, PJM depended on neighboring regions for reserve support. While there were no loss of load events, PJM deployed emergency energy from neighboring regions, internal generators, and demand response
  - Significant market uplift charges as LMPs did not fully capture costs of committing and running resources
  - PJM identified ~30 hours during the Polar Vortex and Winter Storm event which would qualify for capacity performance

PJM implemented capacity performance in response to the transition from coal to gas as the primary fuel; Public policy is heralding in another energy transition and market signals should value operational risk

Design Elements of Capacity Performance

- Performance Assessment Interval (PAI) can occur RTO-wide, regionally, zonally, or sub-zonally with Penalty Rates based on (Net Cone * 365) / (PAH) - ranges between ~$2,000 to $2,825 per MWh
- **Load Impact -** While a performance event indicates under-procurement of reliable capacity, PAI do not directly affect load settlement in either the RPM or Energy market processes
- **Performance Measurement -** Performance expectation calculated dynamically based on the product of each unit's RPM Delivery Year commitment level and the balancing ratio
  - Expected Performance = Committed UCAP * Balancing Ratio
  - Actual Performance = Real-Time Dispatch + Reserve Commitment – Expected Performance
- **Performance Incentive –** All resources can earn performance incentive
  - Energy resources that do not have a must-offer obligation are paid bonuses based on their full delivered energy; whereas CP resources are only paid bonus above the expected performance level
  - Bonus revenue is prorated based on the total penalty collection and resources eligible for bonus, which includes non-CP resources

Recent Design Changes

Because of the lack of recent widespread performance events in PJM, the MMU requested that FERC direct PJM to revert the Market Seller Offer Cap back to net avoidable cost-based approach for existing resources

This Action:

- ❑ Became effective for the 2023/2024 delivery year
- ❑ May not fully recognize that existing reserve margins are unlikely to persist, and that the next energy transition will bring in resources with more varied reliability attributes
- ❑ May create disconnect between supplier’s judgement of risk and costs in the annual Base Residual Auction versus risks suppliers face operationally in the market
- ❑ May create uncertainty or inconsistency in accepted approach for recognizing CPQR in offer caps

It is ideal to have a dynamic modeling framework that accounts for integrated set of market, regulatory, and operational considerations

Resource Mix

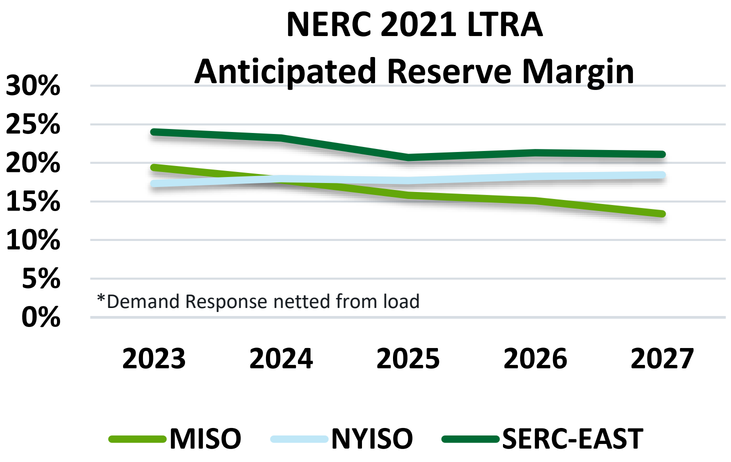
PJM Internal Installed Capacity (CIR MW*)				January EFORd	
Technology	Summer 2024	Jan-2014	Jan-2025	2014	5-Year Avg
CC GAS	58,282	25,329	58,282	8.1	3.5%
COAL	38,202	64,858	38,202	11.5%	10.4%
NUCLEAR	32,649	33,771	32,649	3.0%	0.4%
OTHER	258	269	258	-	11.2%
PEAKING	37,145	36,615	37,145	18 – 45%	9.0%
RENEW	3,444	4,057	3,444	-	6.2%
HYDRO	5,131	5,428	5,131	2%	6.0%
SOLAR	4,527	92	5,608		
WIND	1,545	883	1,545		
Total	181,182	171,302	182,264		
Demand	150,307	141,866	135,521		
IRM	21%	21%	34%		
90/10 Peak	158,978		146,426		
IRM 90/10	14.0%		24.5%		

Note. Solar winter capability is much less than summer CIR but offset by higher wind winter capability at expected 2024 levels

The IRM target was 15.3% in 2014 compared to 14.8% in 2024/25 reflecting the shift from coal to gas. Capacity Performance **with consistent offer caps** was instrumental in ensuring reliable transition

- ~14 GW of coal in PJM planned to retire or convert to gas by 2028 due to combination of CCR or ELG rules
- Solar accounts for 45% of the ~15 GW advanced (i.e. ISA) in the study process; and solar + storage account for 90% of Active Queue

- The general trend is towards lower reserve levels in neighboring regions
- As reserve levels decrease, the ability to depend on neighbors during shortage conditions will decrease as a function of weather diversity

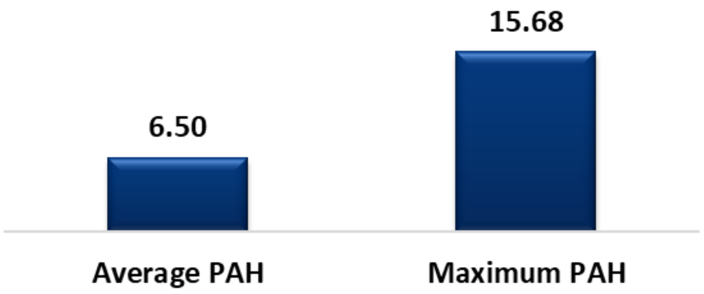


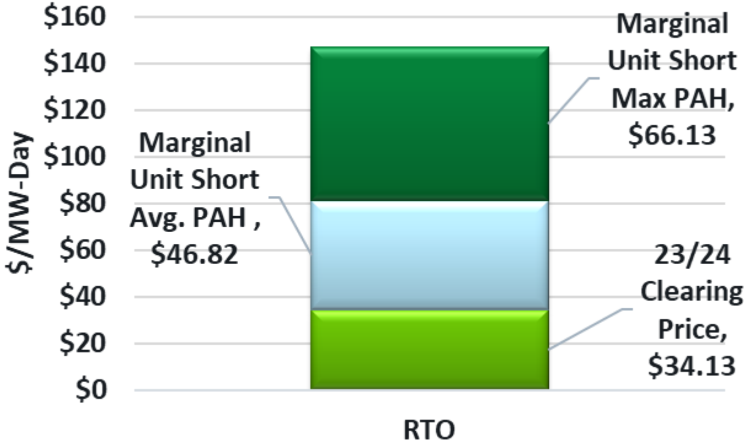
Source. PJM RPM Resource Model published 03/14 and 08/25. EFORd data from PJM Data-miner 2. Load from 2022 PJM Load forecast report

Shortage Event Simulation

- Simulated PJM footprint including net firm imports for June 2024 – Oct 2024 delivery year using PSO/Enelytix Production Cost software
  - Monitored Interface constraints and 230 kV and above branch contingency constraints
  - Unit minimums, ramp-rate, cycling transition times enforced
- Simulated a prior day (2 days look ahead) and same day cycle (rolling horizon)
  - Locked unit commitment for all ST units based on prior-day cycle
- Analyzed 22 Weather Years x 500 forced outage distributions in the same-day cycle x 1 Planned Outage Distribution
- Shortage identified based on an LMP threshold of 3 x Reserve Penalty Price (30-minute, 10-minute Synchronous and Non-Synchronous)

Note: Initial Modeling results are indicative based on assumptions used in the simulation





*Based on RTO Penalty Rate assuming unit on outage in all shortage periods

Observations

- Since 2014, PJM transitioned from a coal-dominant to gas-dominant system
  - Capacity Performance was instrumental in ensuring the transition occurred reliably by tying the forward capacity market auction with strict operating expectations for resources
- While the PJM footprint has not experienced a repeat of the polar vortex, continued retirements of resources due to regulatory and economic drivers are expected to increase operational risk for remaining generators which should be reflected in resource offers
  - Relying on historical market performance for shortage expectation may raise concerns with a changing grid; a robust modeling framework that captures resource economics, resource operational limitations, and transmission system capability is ideal to assess system risks and develop appropriate market design for auctions
- As reserves decline and the resource mix continues its transition to more variable resources, consistent price signals are needed to ensure adequate investment in resource reliability

Additional Modeling Considerations

ISO

- ❑Provide greater transparency on outage data (frequency, outage causes and outage duration, partial versus full) without impacting competitive outcomes
- ❑Provide analysis on weather versus outage frequency sensitivity and relationship between weather and outage duration
- ❑More details on technology (e.g. battery storage characteristics) employed in queue projects and more comprehensive assessments of commercial probability

Additional Modeling

- ❑Higher levels of renewable penetration and weather year dependent shapes
- ❑Evaluate impacts of load forecast error between the DAM and Real-time cycle and the impacts of transmission outages
- ❑Scenarios on interconnection queue project viability
- ❑Evaluate more outage draws