



PJM Basics: Introduction to PJM

Annual Ohio Energy Management Conference
February 27, 2024

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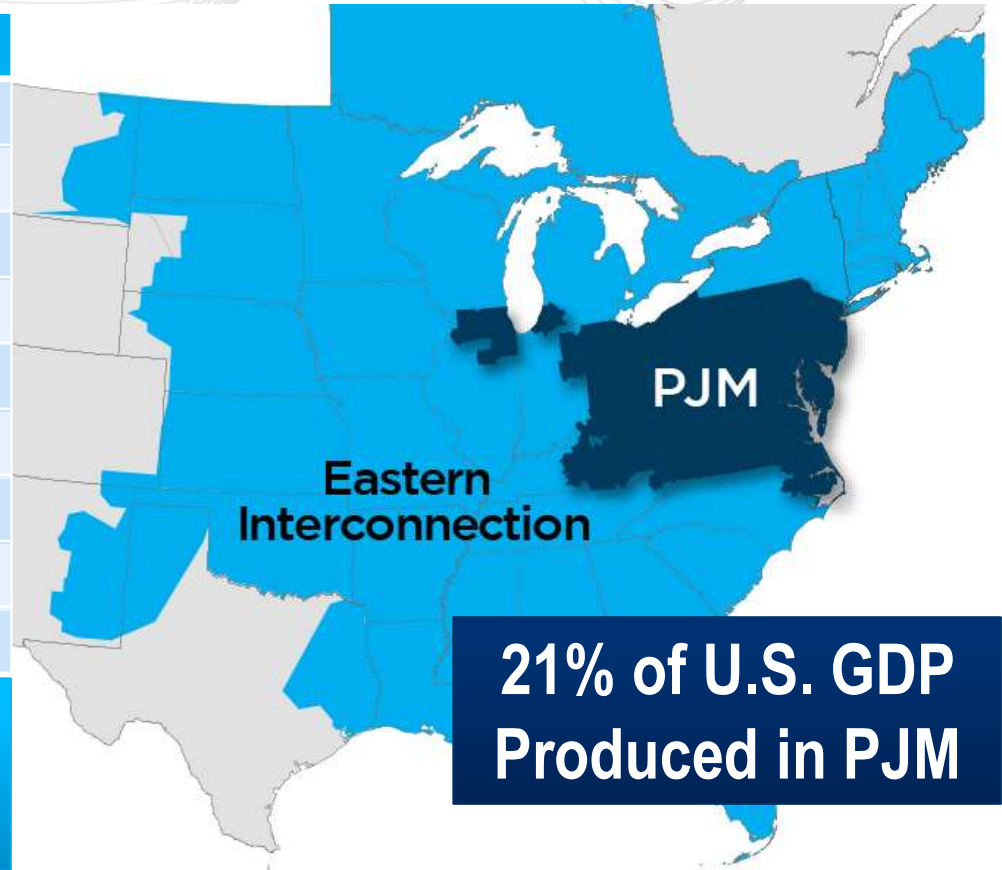


PJM as Part of the Eastern Interconnection

Key Statistics

Member companies	1,110+
Millions of people served	65+
Peak load in megawatts	165,563
Megawatts of generating capacity	183,254
Miles of transmission lines	88,115
Gigawatt hours of annual energy	795
Generation sources	1,419
Square miles of territory	368,906
States served	13 + DC

- 26% of generation in Eastern Interconnection
- 25% of load in Eastern Interconnection
- 20% of transmission assets in Eastern Interconnection



As of 2/2023



PJM's Role as a Regional Transmission Organization

PLANNING



Planning for the future like...



OPERATIONS



Matches supply with demand like...



MARKETS



By Zone	
AE	\$20.59
AFP	\$25.55
AFS	\$25.18
ATSI	\$25.46
RC	\$37.91
COMED	\$25.68
DAYTON	\$26.22
DFOK	\$25.38

Energy Market Pricing like...



How Is PJM Different from a Local Utility?



Agreement for Operational Control

Independence, Neutrality



Coordinate Systems



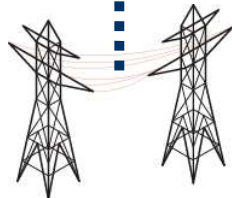
Independent Board of Managers

Market Monitor

Members Committee



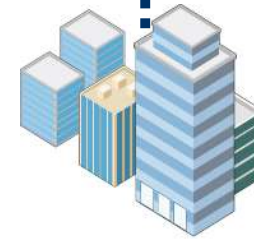
Generation Owners



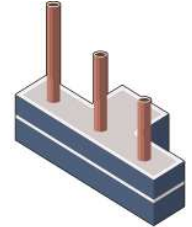
Transmission Owners



Competitive Retail Companies & Trading Companies

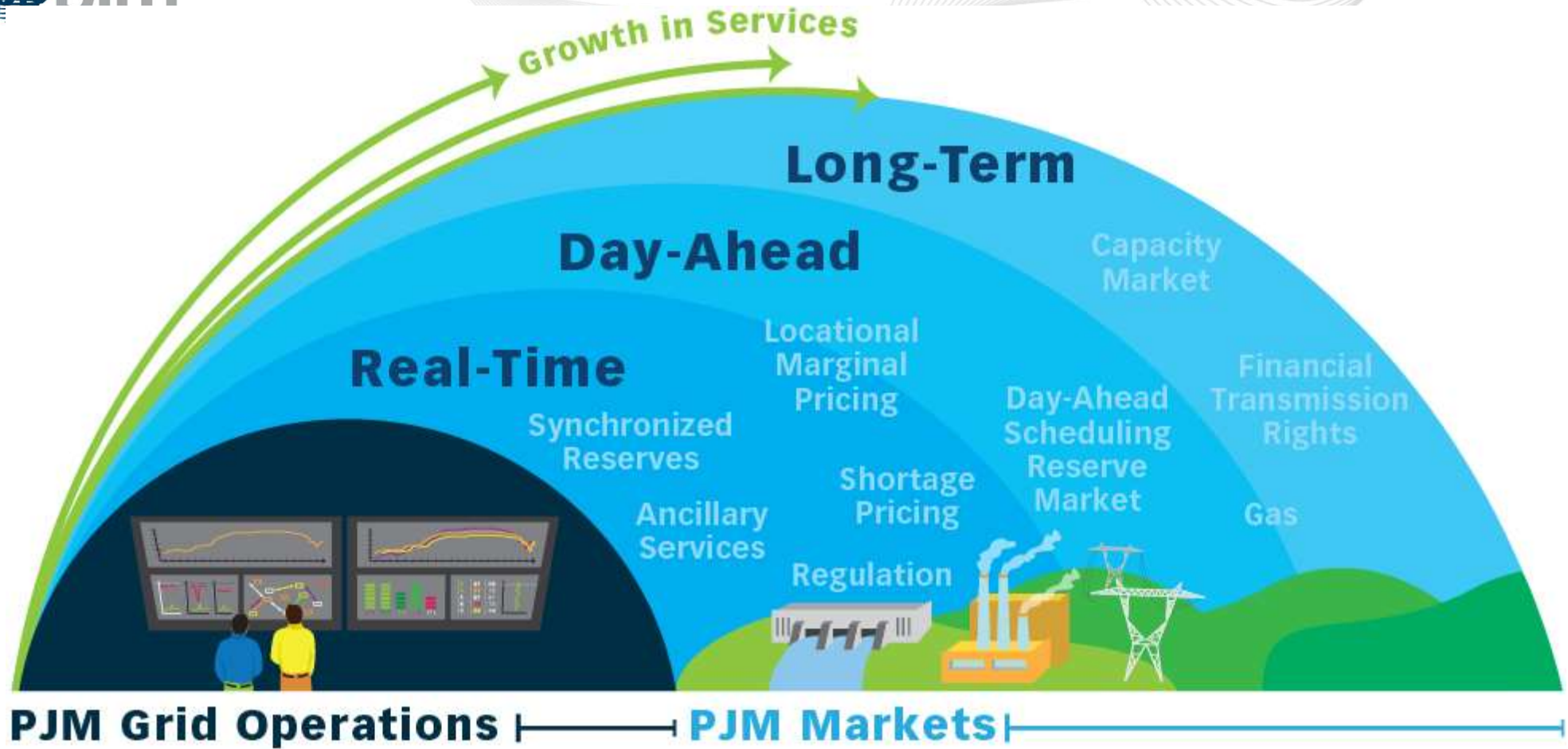


Utility Electric Distributor & Retail Business



Wholesale End Use Customers (Industrial)

- Independent Board of Managers
- Stakeholder process – provide balanced stakeholder input
- Established process for discussion of market evolution
- ISO funding and startup



Compensation to supply resources in PJM market comes from the sale of three products:

1

Energy

2

Ancillary Services

(reserves, regulation, reactive, blackstart, etc.)

3

Capacity

The existing compensation for energy and ancillary services may not be adequate for supply resources necessary to maintain reliability to recover their cost to stay in service.

- The purpose of capacity market is to provide a mechanism for supply resources to compete for these additional revenues to ensure costs are minimized.
- By accepting a capacity commitment, suppliers accept performance obligations.

PJM made two filings on October 13, 2023 to make enhancements to its capacity market.

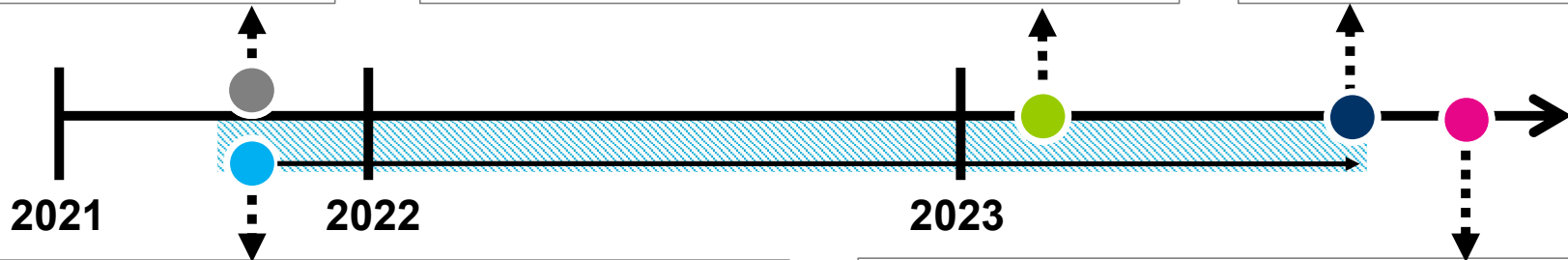
The motivation for these changes primarily comes from opportunities to:

- Enhance the modelling methods used to identify resource adequacy risks and accredit resources.
- Refine market rules from experiences with operating and participating in the capacity market.
- Improve rules in response to recent operational experiences and market outcomes during cold weather events.

October 2021 – Resource Adequacy Senior Task Force begins, the initial stakeholder process that led to this filing.

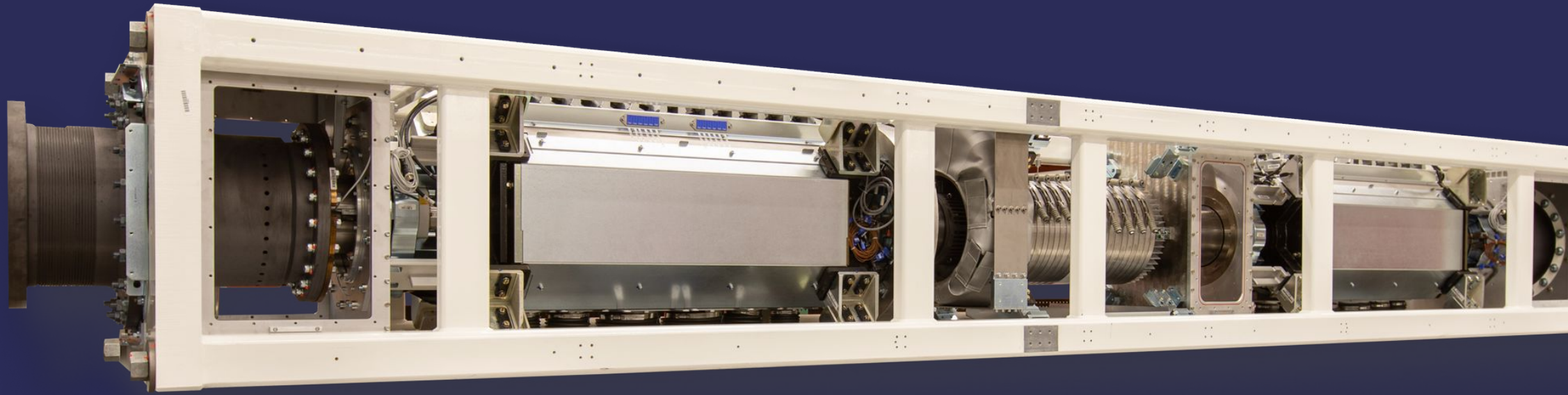
February 2023 – PJM Board initiates the Critical Issue Fast Path process, which identified prioritized scope and set a deadline to file of October 1 (later updated to October 13).

August 2023 – Stakeholders presented proposals to the PJM Board and members conducted an indicative vote.



October 2021 to August 2023 – 47 stakeholder meetings devoted to enhancing the capacity market.

October 2023 – Filing is a result of focused Board deliberation on the various proposals and topics.



Ohio Energy Savings & Management

PJM's Capacity Market Reforms and Customer Solutions
February 27, 2024



Today's Speaker

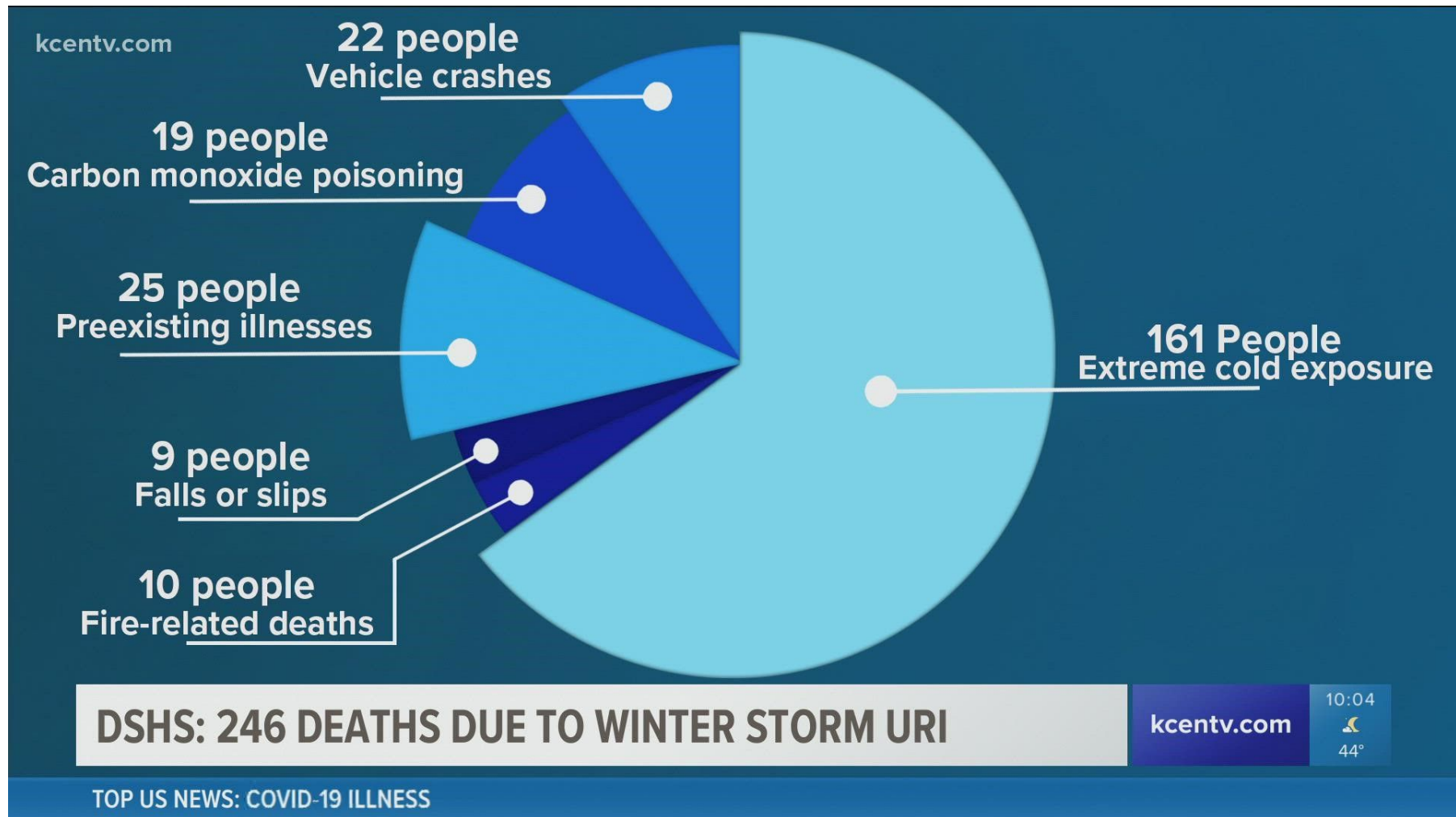


Brian Kauffman, Director of Market Development

- 15 years in electric industry
- Expertise in electricity generation and customer solutions
- 8 years as PJM and RTO/FERC stakeholder

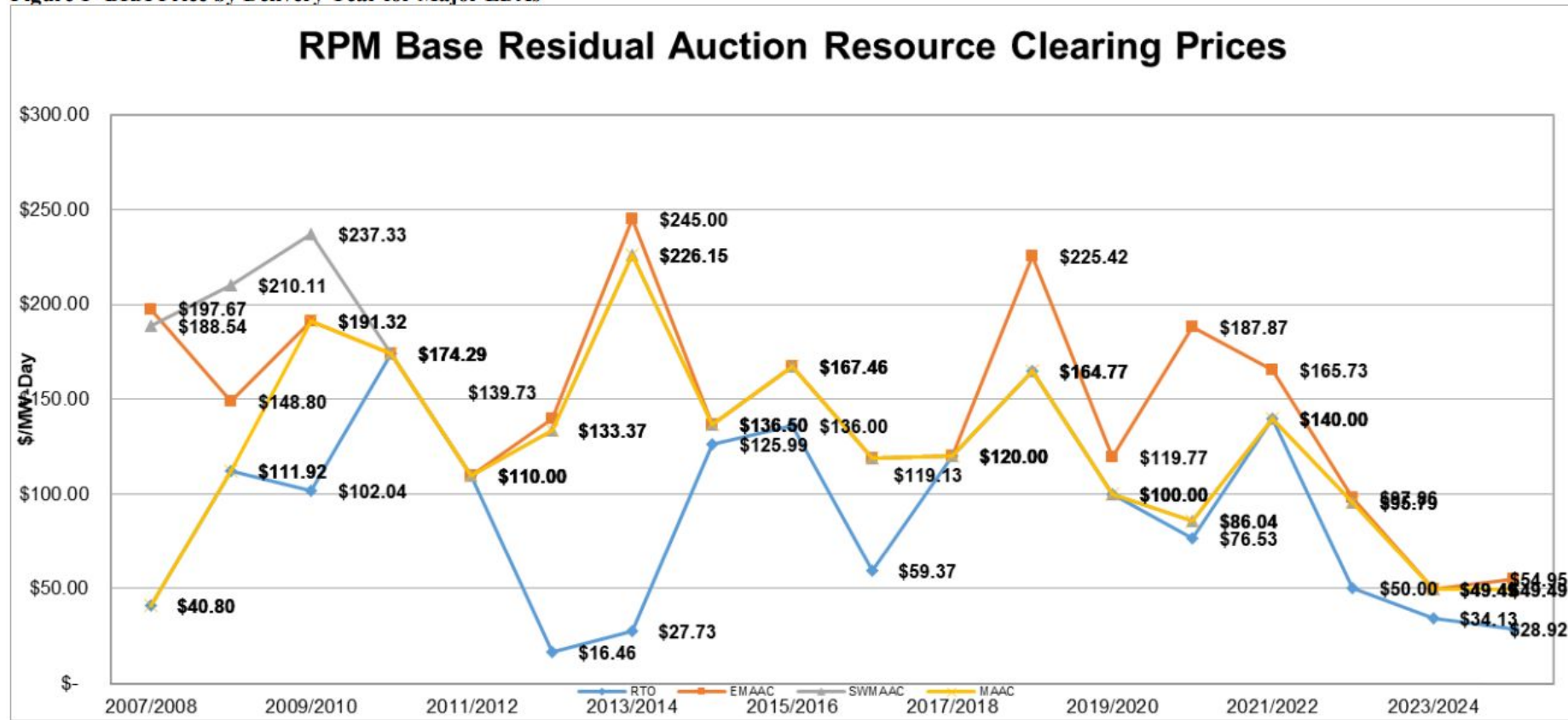
PJM capacity reforms from a stakeholder perspective

Situation in 2021: Uri underscores threat of extreme weather and correlated generation outages



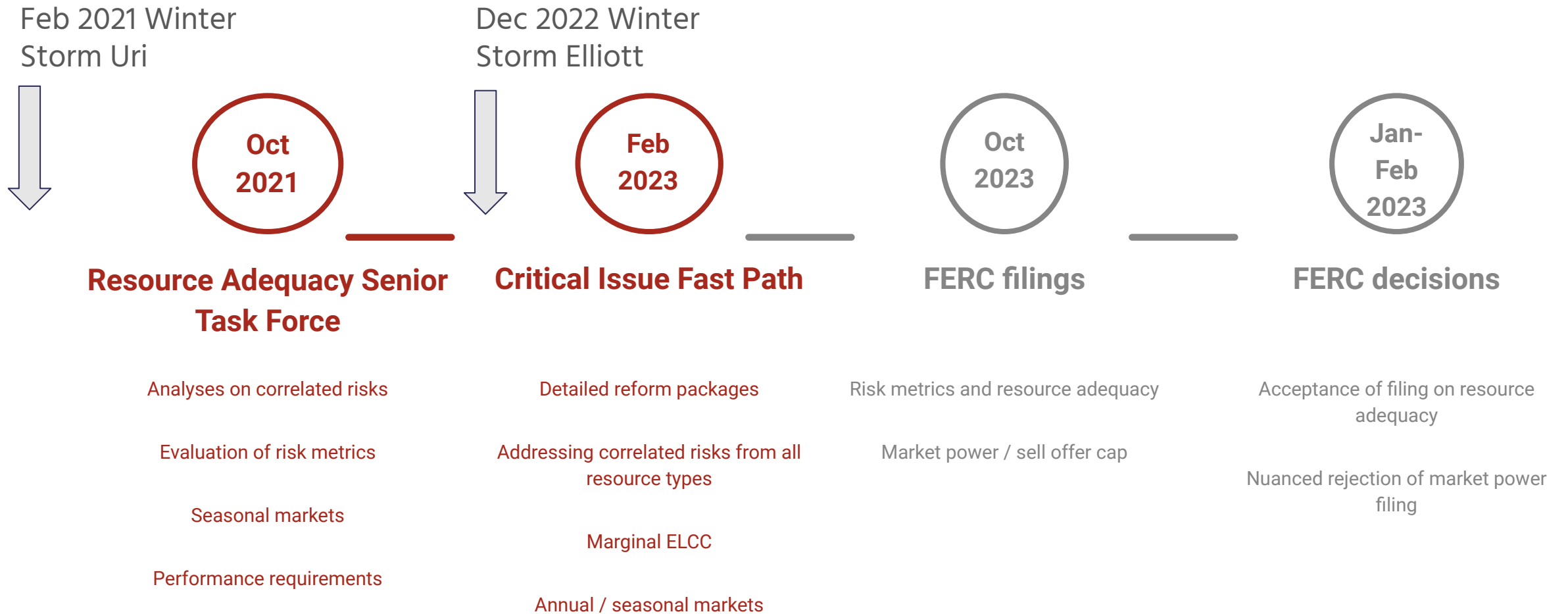
Situation in 2021: Declining capacity prices raise questions for reliability

Figure 1- BRA Price by Delivery Year for Major LDAs

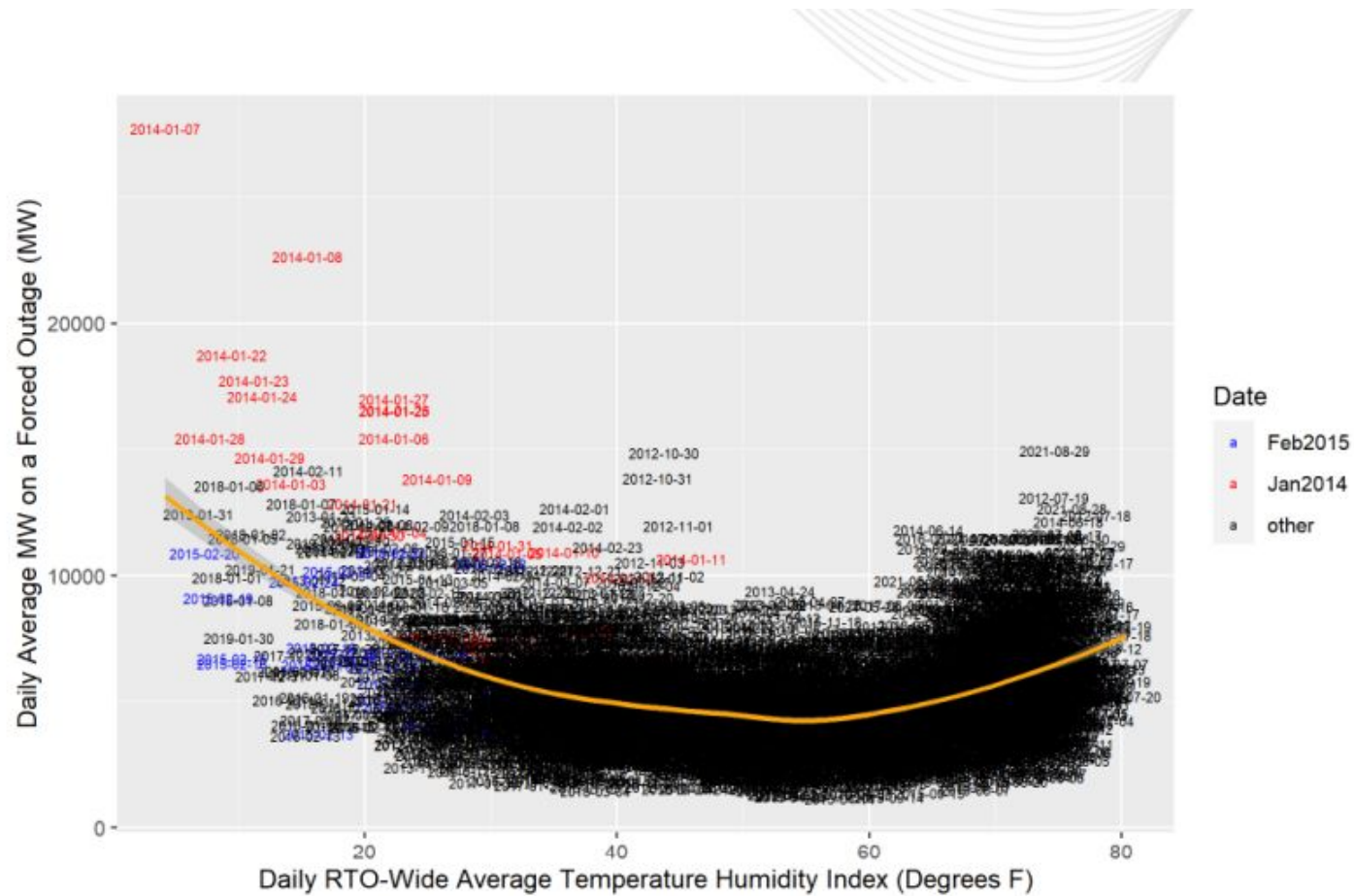


* 2014/2015 through 2024/2025 Prices reflect the Annual Resource Clearing Prices.

Pathway to PJM reforms



PJM analyses find meaningful outage correlation to weather



Results: Major generator rating changes to work themselves out in markets

ELCC Class Ratings for the 2025/2026 Base Residual Auction

The following table provides the ELCC Class Ratings applicable to the 2025/2026 Base Residual Auction (BRA) as calculated under the methodology approved by FERC on January 30th, 2024 in [Docket No. ER24-99](#).

	2025/2026 BRA ELCC Class Ratings
Onshore Wind	35%
Offshore Wind	60%
Fixed-Tilt Solar	9%
Tracking Solar	14%
Landfill Intermittent	55%
Hydro Intermittent	36%
4-hr Storage	59%
6-hr Storage	67%
8-hr Storage	69%
10-hr Storage	78%
Demand Resource	77%
Nuclear	96%
Coal	85%
Gas Combined Cycle	80%
Gas Combustion Turbine	62%
Gas Combustion Turbine Dual Fuel	78%
Diesel Utility	90%
Steam	70%

Source:

PJM, February 5, 2024

<https://www.pjm.com/-/media/planning/res-a-deq/elcc/2025-26-bra-elcc-class-ratings.ashx>

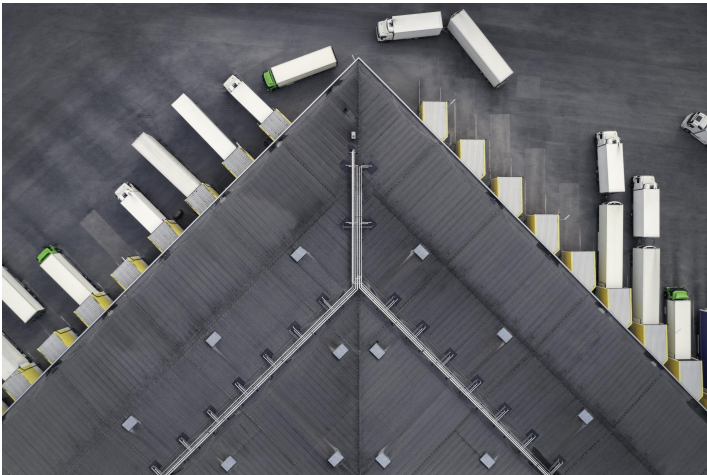
Open questions ahead

- Will reforms drive reliability enhancements for legacy generation?
- Will new, dispatchable generation show up?
- Will customers participate as enrolled PJM demand response or increasingly as load modifying resource outside of PJM?
- Will PJM load growth tighten reserve margin?

Implications for Ohio's C&I customers

Solving top challenges to get to the net-zero grid

Capacity



Rapidly add capacity to enable electrification and grid expansion

Resilience



Deploy locally to defend against grid outages and extreme events

Long-Duration Firming



Ensure power supply across days, weeks, and seasons

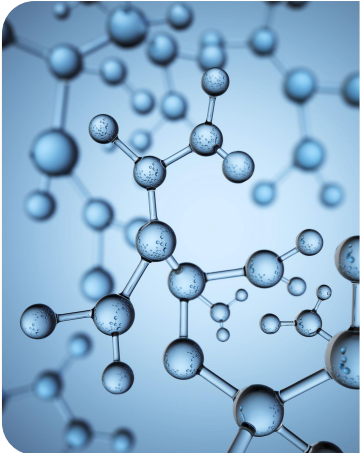
Criteria to use in selecting customer solutions



Cost and reliability



Modularity and speed to power



Low-carbon readiness



Run-time limitations

Local, scalable, fuel-flexible power

The Mainspring Linear Generator

Commercial Behind-the-Meter



Grid-Scale Capacity



Rendering of an 18 MW linear generator array

Local + clean fuels technology landscape

	Linear Generators	Batteries	Natural Gas Fuel Cells	Engines
Scalability	✓	✓	✓	Less efficient with more modularity
Long Duration	✓		Baseload only	Air permit limited
Cost Effective	✓	If long duration doesn't matter	High Capex and O&M	Less efficient and high O&M (especially for local projects)
100% Hydrogen Ready + Fuel Flexible	✓	N/A	Not Fuel Flexible	Blending only
Low Emissions	✓	✓	✓	With after-treatment
Ramping and Stop-Start Flexibility	✓	✓		Slower



Thank you

Appendix

Ultimate flexibility in power generation



Any Fuel

Software control of every reaction means seamless change from hydrogen, ammonia, RNG, natural gas, and others

Any Scale

Scalable from behind-the-meter applications to grid-connected utility projects

Any Time

Firms the grid with fast-ramping, dispatchable power to compensate for increasing levels of weather dependent resources

Anywhere

Mobile and modular. Easy to permit, install, and interconnect.

Delivering power for trusted top-tier partners

\$150M NextEra Financing Agreement

“Mainspring is able to integrate clean onsite generation with both renewables and the grid and we're pleased to support bringing this innovative product to market.”

John Ketchum
NextEra Energy President and CEO



In-Field Power Generation Experience

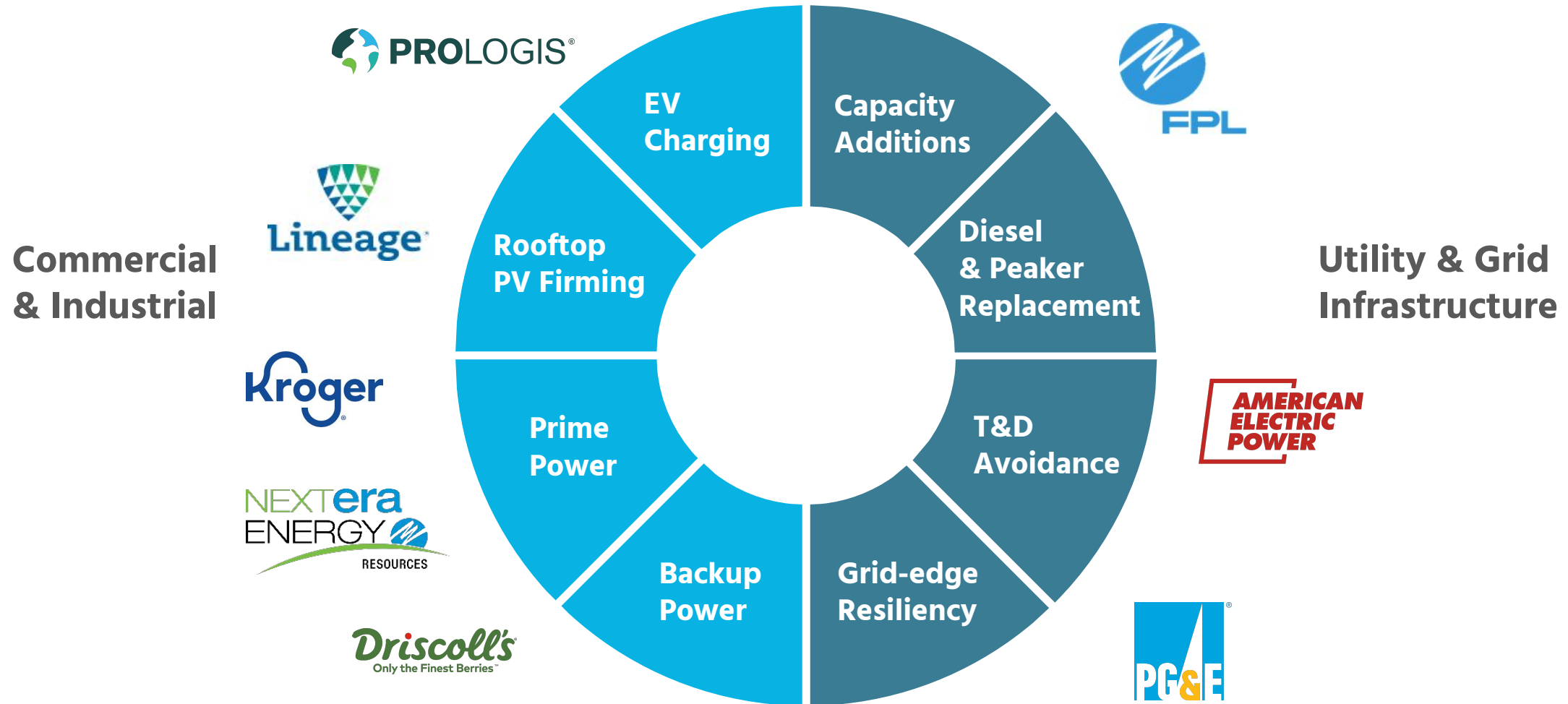
30+
Years
Core
Run Time

3+
Years
Customer
Operation

Availability
Beats
Industry
Averages¹



Clean firm power for a broad range of needs



Uninterrupted power delivery in extreme conditions

HURRICANE

Vero Beach, FL

Event: Category 4 hurricane

Duration: 3 days

Outcome: Uninterrupted operation



EXTREME HEAT

Multiple locations in CA

Event: Max heat of 109°F Aug. 2021

Duration: 2 days

Outcome: Uninterrupted operation



EXTREME COLD

Fargo, ND

Event: Cold weather testing

Duration: Intermittent testing

Outcome: Reliable start at -10°F,
successful runtime down to -20°F



Lineage pairs Mainspring with rooftop solar



- Installation of 3.3 MW solar array and two Mainspring Linear Generators for firming
- Reached deal to deploy up to 150 Mainspring units across 50 US facilities (2022-24)

“Mainspring’s technology will help support our move to net zero carbon energy, improve energy independence, and buffer our growing use of solar power, while offering the potential future use of zero carbon fuels like green hydrogen and others.”

Chris Thurston, Director of Energy & Sustainability, Lineage Logistics



The Lineage Logistics cold storage facility in Colton, CA

Clean, onsite EV fleet charging



- Speeds power build-out for EV expansion
- Builds local resilience
- Incentivizes investment in EV fleets
- Fuel-flexibility reduces risk
- Local installations reduce grid congestion

Mainspring delivers Prologis cost savings over traditional generators AND a path to clean fuel alternatives while shrinking the time to power from more than 2 years to 8 months.



Rendering of 9 MW truck fleet EV charging microgrid

AEP avoids transmission constraints



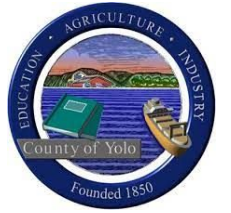
- Perfectly sized, easily permitted projects
- Lower cost, longer duration than batteries
- Island-mode capable, clean-fuel ready
- Mobile and seasonal deployment options
- Accelerates electrification for EVs, buildings

“We are very interested in the scalability of Mainspring's flexible platform and its potential use in a variety of applications from customer-resiliency projects to grid-scale power plants.”

Carlos Casablanca, Managing Director, Distribution Planning and Analysis for AEP



Yolo County, Calif. runs 100% landfill biogas



- Municipal solid waste landfills are the 3rd largest source of human-related methane emissions in the U.S.
- Fuel-agnostic linear generator can convert variable biogas to electricity onsite

“We are excited to partner with Mainspring and continue to demonstrate production of renewable electricity using a new and innovative technology that has the potential to increase efficiency of electricity production and reduce air emissions.”

Ramin Yazdani, Director of Integrated Waste Management, Yolo County



Napa Sanitation improves wastewater biogas operations

- Reduces cost and increases resilience for an essential public service
- Contributes to organization's Climate Change Mitigation Plan by lowering emissions
- Increases utilization of anaerobic digester

"The linear generator is an important component of our Climate Change Mitigation Plan. The addition of this Mainspring unit to our plant will help us meet our clean energy goals, reduce greenhouse gas emissions, and create operational efficiencies."

Tim Healy, General Manager, NapaSan



Diesel replacement at data centers

- Offers clean reliable power to data centers constrained by diesel to meet carbon goals
- Avoids power delivery delays
- Offers fuel flexibility - no other tech can run on hydrogen and ammonia, saving space and cost
- Long duration resilience that can't be met with batteries



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Recent PJM Capacity Market Reform Proposals: Where Things Stand

Glenn S. Benson

February 27, 2024



Orders on PJM's Proposed Changes to its Tariff and Reliability Assurance Agreement

- *PJM Interconnection, L.L.C.*, 186 FERC 61,080 (Jan. 30, 2024) (“Order Accepting Tariff Revisions”).
- *PJM Interconnection, L.L.C.*, 186 FERC 61,097 (Feb. 6, 2024) (“Order Rejecting Tariff Provisions”)

Capacity Accreditation

- PJM proposed to replace its current “average” Effective Load Carrying Capability (ELCC) capacity accreditation method with a “marginal” ELCC approach that accredits all Generation Capacity Resources and Demand Resources based on their marginal Expected Unserved Energy (EUE) benefit.
- FERC found that PJM’s proposal reasonably values resources’ capacity based on their expected incremental contribution to resource adequacy across reasonably anticipated load, weather, and resource availability scenarios.
 - incorporates the risk of correlated outages, especially in cold weather conditions, of all supply-side resources, including thermal resources;
 - reflects the fact that dual fuel resources are more likely to be available than gas-only resources during certain system conditions;
 - accounts for the fact that highly correlated resources such as solar and short-duration storage resources generally provide less reliability value as more of those resources are added to the system;
 - accredits all resources within an ELCC class with identical performance characteristics equivalently; and
 - provides a reliability-neutral basis for comparison between different resource types that will allow PJM’s capacity market to substitute one resource type for another on the margin without affecting reliability, even considering present and future resource adequacy challenges.

Reserve Requirement Study

- PJM proposed to expand its current resource adequacy risk modeling, i.e., the Reserve Requirement Study, to consider all hours of the delivery year under system supply and demand conditions consistent with meeting the one day in ten years Loss of Load Expectation (LOLE) target, instead of just analyzing the peak hour of each day as was done previously.
- FERC found this to be a reasonable modeling methodology that allows risk to be evaluated on a more granular level and provides for consistency between the system's resource adequacy requirements and resource ELCC accreditation to meet those requirements.

Resource Testing Requirements

- PJM proposed to enhance its resource testing requirements to ensure capacity resources are physically capable of responding during a Performance Assessment Interval (PAI).
- FERC approved, finding that the proposed additional testing requirements should:
 - enable PJM to more accurately assess a resource's physical capabilities and expected availability during periods of system stress;
 - help PJM and generation owners identify and correct mechanical issues;
 - incentivize generators to keep PJM apprised of their operational status; and
 - incentivize resources to be available without being overly punitive.

Non-Performance Charge Limit

- This limit or “stop loss” provision is intended to protect resources against excessive penalties resulting from an unforeseen event, while still retaining an appropriate incentive for each resource to respond during an emergency.
- PJM proposed to change the method for calculating the limit to make it reflect capacity prices and revenues to help maintain robust competition in the capacity market by safeguarding against the potential for resources to lose multiple years of capacity revenues.
- FERC approved, finding that considering the totality of PJM’s proposed capacity market reforms included in this proceeding, PJM’s proposed limit strikes a reasonable balance between incentivizing performance during emergency events and ensuring the economic viability of providing capacity in PJM.
 - maintains a key element of PJM’s existing stop loss—“put[ting] at risk full capacity auction revenues if a resource completely fails to perform during Performance Assessment Hours.
 - capacity resources will also have an incentive—even after hitting the stop loss—to perform during an emergency event when scarcity pricing is in effect to obtain the higher energy prices associated with scarcity pricing.

Standalone Unit-Specific Capacity Performance Quantifiable Risk (CPQR) as Offer Cap

- For resources that would continue to participate in Energy and Ancillary Services (EAS) markets regardless of whether they receive a capacity commitment, PJM proposed having an offer cap that is no less than their incremental cost of providing capacity.
- FERC agreed that a competitive offer should generally reflect only incremental costs that are avoidable if the resource does not receive a capacity commitment.
- However, PJM failed to propose a defining principle to differentiate between such incremental costs and costs incurred for other purposes, such as to enhance EAS revenues.
 - “PJM proposal seems to require PJM to employ a subjective assessment as to the intentions underlying complex investment decisions of sellers participating in a variety of markets, i.e., the capacity, energy, and ancillary services markets, and bilateral transactions.”
- Thus, capacity offers subject to the offer cap remain limited to the resource’s unit specific net Avoidable Cost Rate, which is net of EAS revenues.

Standalone Capacity Performance Quantifiable Risk (CPQR)

- Sellers undergoing unit-specific review may choose to include CPQR in their proposed offer caps.
- PJM proposed a standard methodology by which PJM would calculate CPQR on behalf of the seller.
- FERC rejected the proposed methodology as insufficiently transparent. PJM:
 - did not offer to make its proprietary model available to stakeholders; and
 - did not explain the assumptions used in the model or whether it will modify the model to account for unit-specific accreditation adjustments and other changes to a resource's risk exposure.

Excusals from Performance Shortfalls

- PJM proposed to eliminate provision making resources subject to Non-Performance Charges when they are not scheduled solely due the seller's submission of a market-based offer that is higher than its cost-based offer.
- FERC rejected, reiterating that without it, a resource that did not expect to be able to perform could avoid NPCs by offering well above cost in hopes of not being scheduled.
- While this could force sellers to submit market-based offers equal to their cost-based offers when they expect a Performance Assessment Interval (PAI) will occur, this is a reasonable outcome in that the seller is making an economic decision that reflects its non-performance risk.

Bonus Payment Eligibility

- Currently, any resource—including those w/o capacity commitments and non-firm imports into PJM—that overperforms relative to its capacity commitment is eligible for bonus payments.
- PJM proposed to limit eligibility for bonus payments to committed Generation Capacity Resources with a capacity obligation. In other words, it proposed to exclude:
 - Demand Resources
 - Price Responsive Demand
 - Energy Efficiency Resources
- FERC rejected the proposal, finding:
 - While limiting eligibility will provide stronger incentives to the smaller group of eligible resources, such incentives must be weighed against the reduced performance incentives for other resources.
 - During Winter Storm Elliott, about 40% of overperformance came from resources PJM would make ineligible.
 - Would reduce incentives for non-capacity resources to make forward-looking investments in anticipation of high stress conditions.

Third-Party Verification of CPQR

- PJM proposed to allow sellers to submit a CPQR value that has been reviewed by an independent 3P entity with experience evaluating Capacity Performance insurance policies to confirm the proposed risk valuation is consistent with actuarial practices in the industry.
- FERC rejected because:
 - the proposed tariff language is most reasonably read as requiring PJM and the MM to accept the 3P estimate w/o additional review, which is inconsistent with principles of mitigation; and
 - further clarity is needed regarding how consultant reports would be evaluated and standards for selecting consultants.

Questions?

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Rebecca M. Carroll

Sr. Director – Market Design

Rebecca M. Carroll, Sr. Director of Market Design, oversees the design of PJM's wholesale markets, including the capacity, Day-Ahead and Real-Time Energy, ancillary services and Financial Transmission Rights markets. Carroll has worked for PJM since 1999 and held senior leadership roles in the Market Design & Economics, System Operations, and State & Member Services divisions.

Carroll previously served as the Director of Dispatch in the System Operations division where she was responsible for the oversight and operation of PJM's control centers. In this role, she ensured the reliable operation of the power grid, in accordance with NERC and PJM policies pertaining to the functions of Reliability Coordinator, Balancing Authority and Transmission Operator. She was also responsible for ensuring the efficient economic dispatch of the system under the existing PJM market rules and neighboring Joint Operating Agreements.

Prior to moving to System Operations, Carroll was previously the Director of Member Relations, within the State & Member Services division where she was responsible for proactively addressing Members' training and customer service needs along with facilitating PJM's stakeholder process. Carroll also served as Manager of the Knowledge Management Center where she lead her department in developing, maintaining and managing PJM knowledge as it pertains to member interactions within the PJM business.

Carroll has worked at PJM for over 20 years, primarily in Market Operations, in roles as an engineer through Manager of the Real-Time Market Operations Department, where she focused on the oversight, design, and daily operation of the energy and ancillary services markets and market activities associated with interregional market coordination with neighboring areas.

Carroll earned a bachelor's degree in electrical engineering from Widener University. She previously served on the Board of Directors for the North American Energy Standards Board (NAESB) in the Wholesale Electric Quadrant segment.

PJM Interconnection, founded in 1927, ensures the reliability of the high-voltage electric power system serving 65 million people in all or parts of Delaware, Illinois, Indiana, Kentucky, Maryland, Michigan, New Jersey, North Carolina, Ohio, Pennsylvania, Tennessee, Virginia, West Virginia and the District of Columbia. PJM coordinates and directs the operation of the region's transmission grid, which includes over 84,236 miles of transmission lines; administers a competitive wholesale electricity market; and plans regional transmission expansion improvements to maintain grid reliability and relieve congestion. PJM's regional grid and market operations produce annual savings of \$2.8 billion to \$3.1 billion.



Biographical Information

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One of the country's leading representatives of companies grappling with complex federal and state energy regulatory matters, Glenn Benson brings more than 30 years of experience and an uncommon familiarity with the Federal Energy Regulatory Commission (FERC) to his role on the BakerHostetler national Energy Industry practice team. He counsels clients across the energy industry on tariff and contract disputes before FERC, regulatory compliance and enforcement and the negotiation of commercial transactions, including physical and virtual power purchase agreements, interconnection agreements, pipeline precedent agreements, asset management agreements, electric energy supply agreements, oil and gas purchase and sale agreements, and purchase and sale agreements for renewable energy attributes.

Listed in The Best Lawyers in America® since 2015 in the area of energy law, Glenn's authority on nuanced litigation and complex energy policy issues has led to trusted positions advising and representing electric, gas, and oil companies, as well as large consumers of energy, in every geographic region of the U.S. It has also inspired a high-profile caseload: Glenn handled one of the first offshore natural gas pipeline open and nondiscriminatory access disputes before the U.S. Interior Department's Bureau of Safety and Environmental Enforcement (BSEE).

Brian Kauffman, Director, Wholesale Market Development, Mainspring
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Brian Kauffman has over 15 years in the electricity industry. For much of this time, Brian has led policy and business strategy for organizations involved in equipment manufacturing, project development and energy services to enable the energy transition in a reliable, clean and cost-effective path. Brian is currently Director of Wholesale Market Development at Mainspring Energy. Founded in 2010, Mainspring is a California Bay Area-based manufacturer of an innovative category of power generation called linear generators. This local, scalable, dispatchable, fuel flexible, power generation equipment has a range of use cases including on-site for C&I customers. More information is available at <https://www.mainspringenergy.com>.

As Director of Wholesale Market Development, Brian leads cross-team efforts to gather market intelligence, influence company strategy and educate C&I customers, investor-owned utilities, public power, IPPs, RTOs, FERC and other key stakeholders on Mainspring's technology. Previously, Brian held leadership roles at Enel North America, NRG Energy, and Pennsylvania-based trade association, the Energy Efficiency Alliance. Brian received his undergraduate degree in Political Science at Columbia University in New York City and Master's Degree in Environmental Management with a concentration in Energy Economics at Yale University School of the Environment in New Haven, Connecticut. Brian and his family live outside of Philadelphia, Pennsylvania.