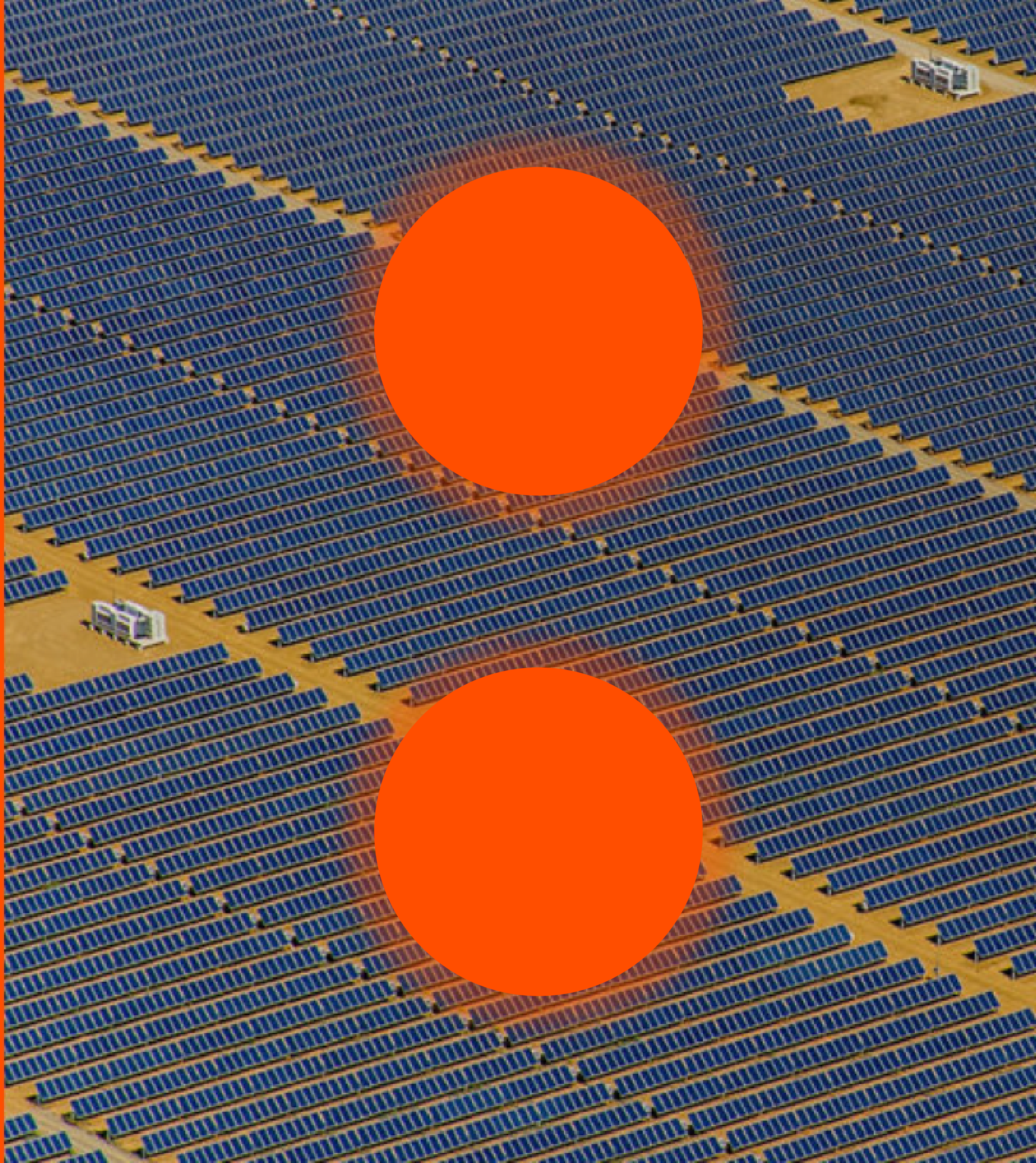
A Perspective on High-Level Design Concepts

You Got Power



Market Design Objectives

We share PJM's overall perspective on the key objectives of the over-arching RA framework:

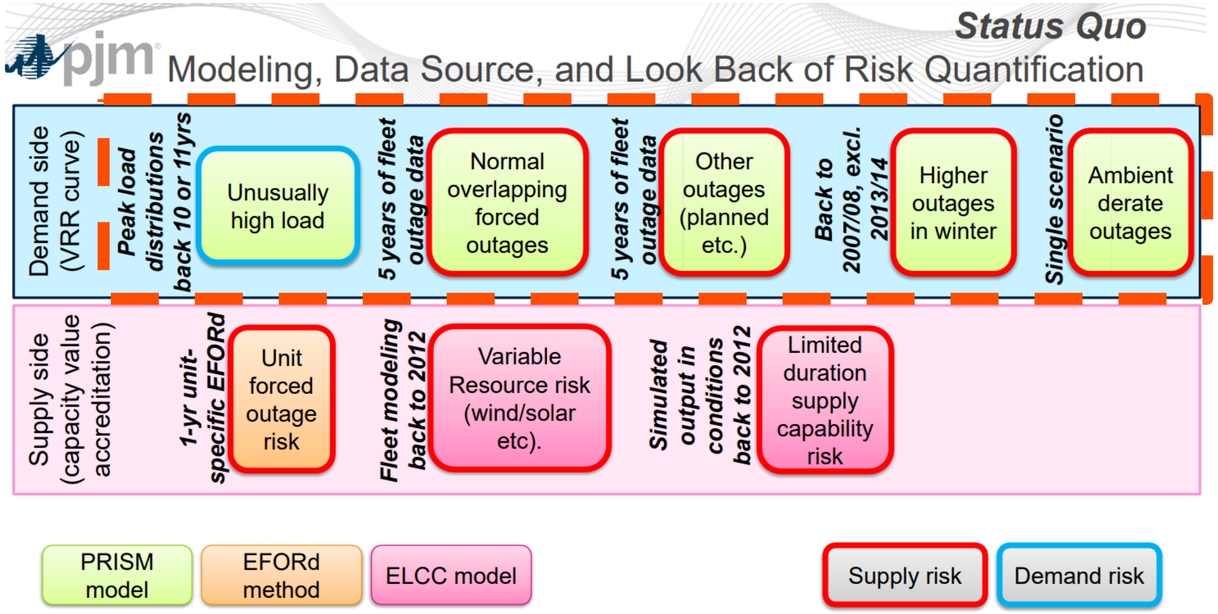
- **Reliability:** supports procurement of sufficient capacity to meet resource adequacy targets
- **Efficiency:** embraces competitive principles, and provides transparent price signals for efficient entry and exit of resources

Capacity Accreditation – Thermals

Resource performance risks should be accounted for on the supply side and applied in a robust fashion across resource classes. This is not the case under the status quo:

- **Inefficient:** many thermal RA risks are not accounted for on the supply side
- **Unreliable:** thermal RA risks are not modelled with as robust a methodology as are ELCC resources (*see next slide*)

Risks	Source	Accounting of Risk
Load Uncertainty	Demand	Demand-side (FPR)
Random Thermal Forced Outages	Supply (thermals)	Accreditation (EFORd)
Variable Resource Risks	Supply (e.g. wind/solar)	Accreditation (ELCC)
Limited Duration Resource Risks	Supply (e.g. battery)	Accreditation (ELCC)
Normal Variability in Random Thermal Forced Outages	Supply (thermals)	Demand-side (FPR)
Thermal Planned & Maint. Outages	Supply (thermals)	Demand-side (FPR)
Thermal Winter Correlated Outages	Supply (thermals)	Demand-side (FPR)
Ambient De-rates (Summer)	Supply (thermals)	Demand-side (FPR)



Capacity Accreditation – Thermals *(continued)*

Key Considerations for Improving Thermal Accreditation

Factor	Principles	Uri Context
Lookback Period	Lookback periods should be standardized to the degree possible to a consensus period that largely captures key events – widely variable lookback periods create divergent outcomes	Uri would likely drive all LOLE risk over any lookback period if the system were modelled *at criteria*, making the lookback period in this context very consequential
Resource Classes	Resource class distinctions become even more important and nuanced for thermal resources and should be rigorously assessed	An additional gas unit with and without on-site fuel would have had immensely different values during Uri – making resource class distinctions for salient drivers of performance is key so that resource are incentivized to invest in their performance
Approach	If marginal accreditation is the approach that is used, it is critical that modelling of all resource classes captures the marginal *unit's* characteristics during RA periods – this is distinct from, say, the tight interval approach, which captures the average performance during the marginal hour and is much more similar to average ELCC	Actual gas fleet performance during Uri was in the ballpark of 60%^, but themarginal gas unit without on-site fuel had zero RA value given fuel system constraints

^ For illustrative purposes only – this is based on an approximate assessment of typical outage levels over the course of Uri, and is not an exact figure

Illustrative accreditation factors for ERCOT gas under different methodologies following Uri

Generalization for Illustration: the worst of Uri was a ~4-day event (02/15-02/18), and gas unit forced outages were around 40% during the event, vs 6.6% expected EFORd for thermals in the ~four years leading up to that point^^. It is likely that Uri would comprise essentially all of the LOLE risk in any RA model of the Texas system *at criteria*, so we assume performance during Uri would completely drive accreditation for this illustration.

Prompt: What would accreditation look like for gas units following this event?

^^ Based on Winter 2017 – Winter 2021 SARA

Approach:	Empirical EFORd, 5 years	Empirical EFORd, 10 years	Empirical Tight Interval, 5 years	Empirical Tight Interval, 10 years	Simulation, Marginal	Simulation, Marginal
Description:	Actual resource EFORd over past 5 years	Actual resource EFORd over past 10 years	Weighted average resource outages based on LOLE windows over past 5 years	Weighted average resource outages based on LOLE windows over past 10 years	Simulated approach looking back over 5 years	Simulated approach looking back over 10 years
Mechanics:	EFORd would increase based on impact of Uri on average EFORd over relevant period (i.e., (6.6% * all non-Uri days + 40% * Uri days) / total days		Uri would comprise the overwhelming majority of LOLE for the applicable period, garnering nearly all of the weighting and causing values to converge on fleet performance during this event		Uri would comprise all LOLE in the simulation, such that gas resources without on-site fuel would have zero RA value due to the gas supply system constraints during the storm	
2022	93.33%	93.36%	60.00%	60.00%	0.00%	0.00%
2023	93.33%	93.36%	60.00%	60.00%	0.00%	0.00%
2024	93.33%	93.36%	60.00%	60.00%	0.00%	0.00%
2025	93.33%	93.36%	60.00%	60.00%	0.00%	0.00%
2026	93.33%	93.36%	60.00%	60.00%	0.00%	0.00%
2027	93.40% (Uri not picked up)	93.36%	Unclear (Uri not picked up)	60.00%	Unclear (Uri not picked up)	0.00%
2028	93.40% (Uri not picked up)	93.36%	Unclear (Uri not picked up)	60.00%	Unclear (Uri not picked up)	0.00%
2029	93.40% (Uri not picked up)	93.36%	Unclear (Uri not picked up)	60.00%	Unclear (Uri not picked up)	0.00%
2030	93.40% (Uri not picked up)	93.36%	Unclear (Uri not picked up)	60.00%	Unclear (Uri not picked up)	0.00%
2031	93.40% (Uri not picked up)	93.36%	Unclear (Uri not picked up)	60.00%	Unclear (Uri not picked up)	0.00%

Note: this treats the gas fleet as a generic resource class. In practice, one would want to distinguish between gas resource classes based on salient characteristics impacting expected performance, e.g., on-site fuel.

Capacity Accreditation – Marginal/Average

There are **pros and cons to both the marginal and average accreditation approaches.**

However, it is not possible to do a comprehensive comparison of these two methodologies without understanding the complete frameworks within which they will be implemented, which is not clear at this stage.

There are critical elements that must be clarified within the context of marginal accreditation in PJM before we can evaluate its merits versus an alternative (average):

- **Capacity Performance:** how would this be structured in a marginal accreditation environment? (*see next slide*)
- **Cost Allocation:** is it Just & Reasonable to allocate capacity costs based on gross peak demand in a marginal accreditation environment and a multi-state RTO? (*see slide after next*)

Capacity Accreditation – Marginal/Average *(continued)*

It is not clear that any of the Capacity Performance models proposed to-date with output-based CP obligations would work in tandem with a marginal accreditation paradigm.

Scenario	Description	Concerns
Status Quo (“SQ”)	Capacity Performance structured around total capacity needs during PAI via Balancing Ratio.	With marginal accreditation, total capacity supply obligations will be below system needs (Demand + Reserves), making the status quo **with the current Balancing Ratio formula inappropriate.**
Amended SQ	Similar to SQ but structured around accredited levels, which are below capacity needs insofar as accreditation < expected fleet performance. PJM’s perspective on 8.29.22: “Set PAI expected performance for gen based on compensated level (UCAP under marginal accreditation).”	**The system is relying on capacity that is not incented via CP**, meaning: • There is capacity needed by the system with no CP obligation during PAIs, **creating reliability risk.** • Most resources will be expected to outperform obligated levels, making CP penalties unlikely and rewards *de minimis*, **diminishing the resultant incentive and reducing efficiency.** • Example: following Uri, assuming an unchanged system, the gas fleet might be accredited at 0% given zero value to the marginal unit, but we would expect it to perform at ~60% during another Uri-like PAI.
Aligned with RA Modelling	Capacity Performance structured around modelled performance levels in RA models; e.g., hourly performance in ELCC model.	This is **not transparent and introduces a significant amount of regulatory risk** – it will be very challenging for parties to assess the capacity performance risk that is born by their resources; RA modelling decisions by PJM will have huge consequences for the Capacity Performance construct. **There are material implementation challenges** – very challenging to translate Monte Carlo RA analysis into obligations during specific hours for CP purposes; similarly, challenging to translate into CPQR for purposes of MSOC.

Capacity Accreditation – Marginal/Average *(continued)*

Imagine two states with equal cost allocation today (equal peak load) and equal *actual* (avg) UCAP supplied.

	GW Capacity	State 1	State 2	Total
A	Actual UCAP Supplied	50	50	100
B	Peak Demand	50	50	100
C	Generation Cap Cost Allocation (Status Quo)	50%	50%	100%
D	Marginal UCAP Supplied	30	50	80
E	Generation Cap Cost Allocation (Marginal) *(B minus [A minus D]) * C*	40	40	80

Result:

- Bost states supply 50 GW RA
- State 1 gets paid for 30 GW RA and pays for 40 GW RA
- State 2 gets paid for 50 GW RA and pays for 40 GW RA

Other Key Components

Component	Consideration for Inter-relations	Some Concerns
Annual/Seasonal Market	• PJM's decision to move forward with an annual or seasonal market will have widespread ramifications for the implementation details of all elements of the capacity market	• **Thermal CA:** with an annual market, a definitive approach to weighting seasons based on LOLE is needed (similar to ELCC models); with seasonal markets, scenario-based accreditation becomes much easier to implement, which can be a valuable tool for incorporating weather event risks • **Marginal CA:** marginal CA requires an adjustment to the demand curve to account for expected levels of capacity provided by resources in excess of their accredited levels; in an annual market with material LOLE risk in summer & winter, this adjustment becomes more complicated given the need to net RA in excess of accreditation out of the VRR • **CP:** management of CP risks looks very different in annual vs seasonal markets
MSOC	• The derivation of MSOC is intimately tied to the capacity performance construct	• **CP:** genuine CPQR risk can look very different depending on the way that the CP construct is structured
Capacity Market Must-offer for ELCC Resources	• The implications of capacity must-offer requirements for ELCC resources are heavily dependent on the ultimate form of CP obligations	• **CP:** the nature of CP obligations will have material implications for the economic impact of a must-offer requirement on ELCC resources; there are scenarios where this could be very problematic, e.g., marginal accreditation with material CP obligations (such as "Aligned with RA Modelling" scenario in Slide 7) with must-offer could undermine the economics of certain resources

Go-forward Process

PJM recognized the inter-related nature of many of the issues that we are discussing in its recent reorganization of the RASTF around a more holistic framework. Given these inter-relations, it is challenging to thoughtfully consider different RASTF reforms in isolation.

To address this, the RASTF would benefit from working on several packages with different foundational components. Given the large number of variables, it would be prudent to identify a few such components and then build the best complimentary architecture around that.

- Approach: consider multiple packages starting with different foundational elements around which there is the least consensus and/or most uncertainty.
- Example: (i) marginal/average; and (ii) annual/seasonal markets.

If certain foundational components are taken as a given (i.e., in the example above, four packages based on the different combinations), more focused discussions can then be had around what the complimentary elements look like in each case, frameworks can be optimized around each package, and at the end of that process, stakeholders can take more informed positions around which over-arching package is best.

Questions?

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