ELCC Modeling Approach

PJM ELCC Sr. Task Force

March 6, 2025

Issue: Oversampling of Weather-Dependent Outages

The single causation of weather to thermal outage rates undermines ELCC modeling and creates the following issues:

Reliability Value	Challenges PJM's ability to link market incentives with changing system conditions and operating practices, a key goal of ELCC accreditation
Volatility	Increases concentration of risk in specific days/seasons. Compounding non-weather dependent and weather-dependent outages can cause an increase in the concentration of risks rather than distributing which has impacts on PJM's planning effectiveness including on setting auction parameters
Investment Signals	Does not adequately distinguish between risks that can be mitigated via plant investment versus more intractable (systemic) risks. Undercuts investment opportunities through diluting their impact on resource accreditation. Specifically, investments that do not improve ICAP but improve availability can take an indeterminant number of years before being recognized in accreditation
Risk Management	Reduces incentives to adjust operator actions and manage risk pro-actively to avoid non-weather dependent outages

Issue: Oversampling of Weather-Dependent Outages

Current Methodology

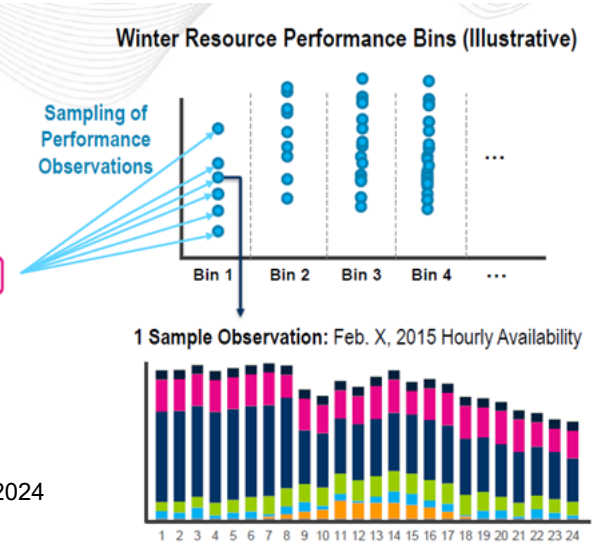
Projected Resource Mix and Performance

Unit, class, and fleet performance for thermal and variable generation modeled as a function of temperature by resampling against historical availability back to 2012 using a binning methodology

- *Dispatch of Demand Resources and Limited Duration Resources simulated in model*

Weather Scenarios

Weather Year	Date	Season	Daily Temp.
197X	Jan. 1	Winter	4° (min)
197X	Jan. 2	Winter	8° (min)
197X	Jan. 3	Winter	7° (min)
	...	...	...
1994	Jan. X	Winter	-5° (min)
	...	...	...
2012	7/15/12	Summer	92° (max)
2012	7/16/22	Summer	89° (max)
	...	...	...
2022	Dec. 31	Winter	12° (min)



Source. PJM ELCC Education, February 2024

- Oversampling occurs when outages are attributed to specific weather conditions, but the outage driver is just as likely to have produced the outage in other weather conditions.
  - For example, instead of 100% of the outage observed on Jan 7, 2014 being represented in a dispatch against load produced with 1994 weather, perhaps only a fraction of the outage should be allocated.
  - And as non-weather dependent load is added the incremental outage risk will be more distributed
- System risks is increasing due to a combination of **non-weather dependent** load growth and correlated generator outage/unavailability risks.
- Can take many years for similar weather to be reproduced which makes it impossible to assess return horizon on both plant and operational improvements.

Current ELCC modeling dose not adequately distinguish between outages that have been coincident with weather events versus outages that are **caused by weather events**.

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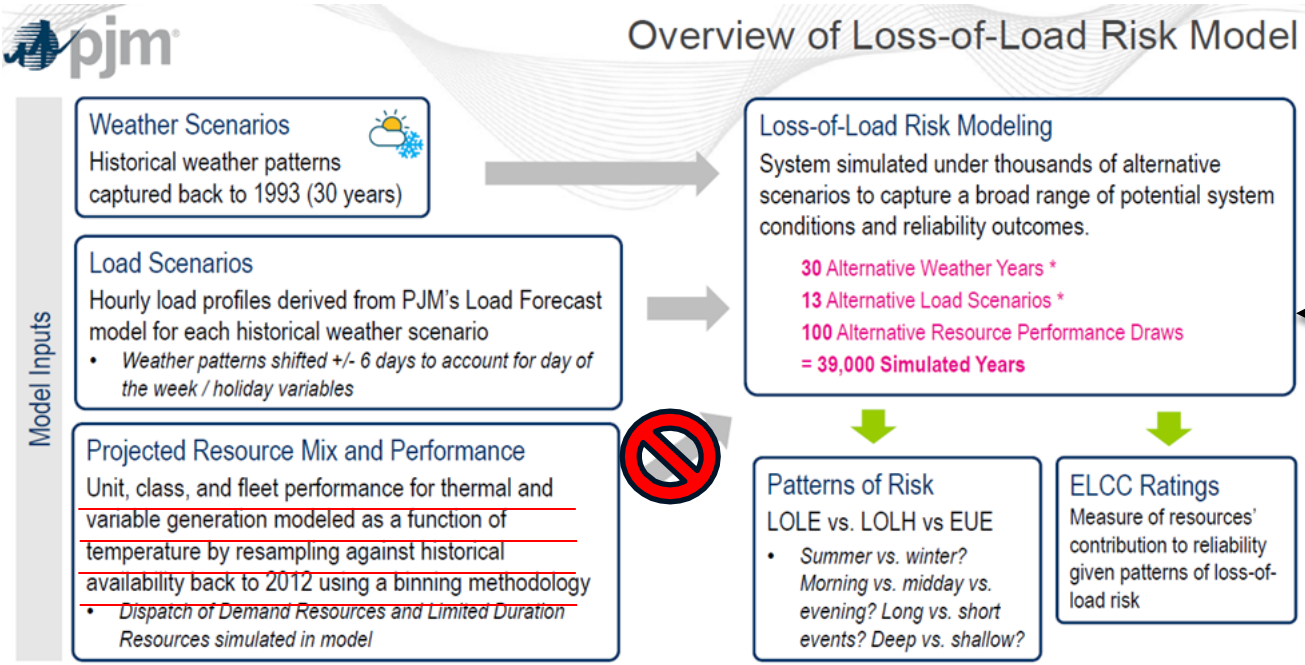
Solution: Define Weather Dependent Vs Asset Owner Unique Outages

	What does it represent	How to Define	Periodicity	Update Frequency
Class-Based Outage Rate ("CBOR")	Shared risks between resources in the same class that is difficult to mitigate consistently through individual resource owner action	Through a statistical significance test applied by generator technology to identify common cause outages. These outage causes are limited to those that are not statistically likely to occur at the same or similar frequency across randomly selected weather bins.	Hourly outage rate selected using existing THI binning and random draw methodology	Every 3-4 years PJM conducts assessment of markets, planning, operations practices to assess categorical risk.
Resource Specific Monthly Outage Rate ("RSOR")	Historically observed outage Rate	Resource GADs history. PJM will have to provide guidance on which outage factor to use (i.e. FOR, EFOR, EFORd, etc)	Annual or Monthly	Every auction based on up-to 5 years of history

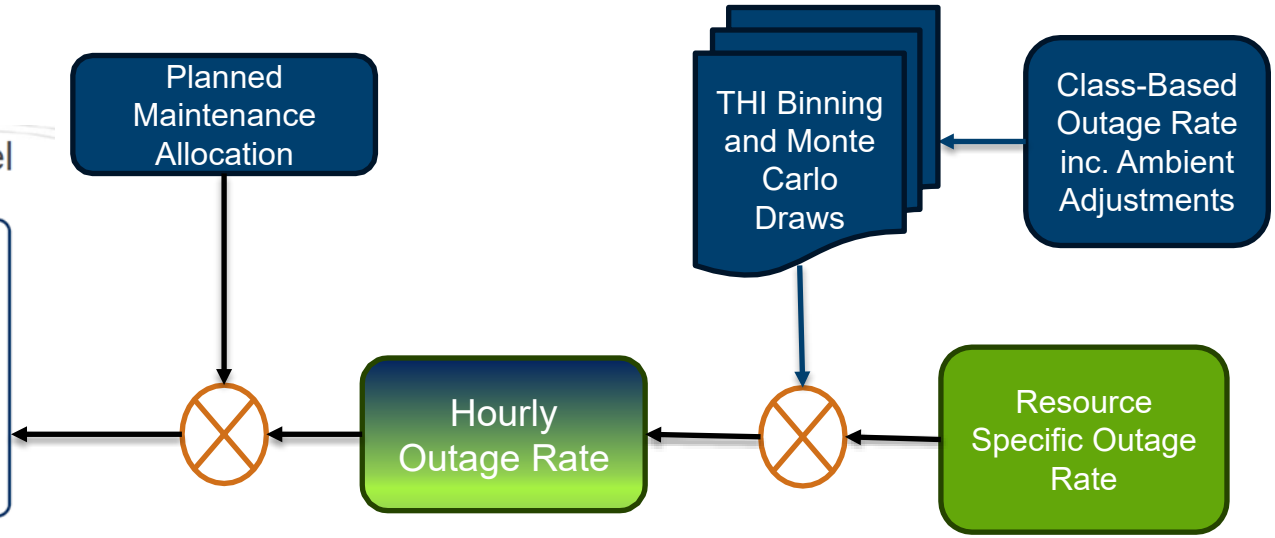
Implementation within ELCC Process

PJM Existing Process



Source. PJM ELCC Education, February 2024

Proposed Input Modification



Class-Based Outage Rate
+ Max { 0, Resource Specific Outage Rate – Class Based Outage Rate}

= Hourly or Daily Outage Rate at Resource Level
(Represents a weather sensitive and plant specific outage rate)

Existing Marginal ELCC framework will be conducted on a resource level to define the Marginal ELCC by resource

Q&A

How will the marginal ELCC modeling methodology be modified	This approach is simply intended to refine the inputs into the ELCC model. The ELCC framework will remain intact. Preserves integrated forward-looking view of resource accreditation tied to future system needs.
How to derive the weather-sensitive versus non-weather sensitive outage factors	Perform Null Hypothesis Test: Outage driver is just as likely to occur in other seasons. ➢If yes -- > Outage treated as within the asset owner's control ➢If no -- > Outage gets added to the class and associated with weather data using binning methodology and random draw
What happens to the performance adjustment	It goes away since marginal ELCC evaluation will be performed for each mature resource
How does evaluation change for variable technologies	The general modeling approach can be applied to both variable and unlimited resources
How will new resources be treated	New resources will receive a class-average marginal ELCC accreditation in the first year of operation; after the first full year of history resources can select their own history for non-weather sensitive outage factor.
How will Incremental Auction Deficiency/Surplus be calculated	Based on changes in ICAP and based on variation between the Final Resource Specific Annual Outage Factor versus the BRA Auction Resource Specific Annual Outage Factor. It is not rational for resource owners to buy-back risk that must be evaluated over multiple years and that the asset owner does not explicitly create nor have control over.
When will the Resource Specific Outage Factor be determined	Since it will be an input into the ELCC model there will need to be a process for members to submit the target rate and for PJM/IMM to approve the value during the pre-auction activities
What will be the limit on the Class-based outage rate	The class-based outage rate in any day should not exceed the median observed rate from amongst resources in the same class

Appendix: Outage Causes

Contribution to PJM EFOF by unit type by cause: 2023

	Coal	Combined Cycle	Combustion Turbine	Diesel	Hydroelectric	Nuclear	Other	System
Unit Testing	4.6%	19.8%	27.5%	30.4%	54.7%	21.4%	35.6%	15.8%
Boiler Tube Leaks	19.4%	5.0%	0.0%	0.0%	0.0%	0.0%	7.8%	11.9%
Boiler Air and Gas Systems	19.6%	0.0%	0.0%	0.0%	0.0%	0.0%	2.9%	10.7%
Electrical	1.6%	29.0%	5.4%	6.9%	3.9%	4.0%	4.0%	7.1%
Regulatory	12.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	6.5%
Feedwater System	4.9%	0.8%	0.0%	0.0%	0.0%	3.1%	3.8%	3.2%
Generator	2.7%	0.8%	12.4%	0.2%	0.8%	3.4%	0.2%	3.1%
Low Pressure Turbine	4.5%	1.1%	0.0%	0.0%	0.0%	0.0%	0.1%	2.6%
Turbine	0.0%	0.6%	11.1%	0.0%	21.5%	0.0%	0.0%	2.3%
Miscellaneous (Gas Turbine)	0.0%	4.9%	13.8%	0.0%	0.0%	0.0%	0.0%	2.3%
Controls	0.8%	6.0%	1.1%	3.4%	0.2%	7.4%	3.7%	2.3%
Auxiliary Systems	1.6%	2.0%	6.1%	0.0%	0.0%	0.0%	0.7%	1.9%
Miscellaneous (Steam Turbine)	0.7%	3.4%	0.0%	0.0%	0.0%	0.0%	9.7%	1.8%
Circulating Water Systems	1.0%	6.6%	0.0%	0.0%	0.0%	0.3%	0.1%	1.7%
Boiler Fuel Supply from Bunkers to Boiler	2.9%	0.1%	0.0%	0.0%	0.0%	0.0%	1.0%	1.7%
High Pressure Turbine	3.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.4%	1.6%
Wet Scrubbers	2.8%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1.5%
Fuel, Ignition and Combustion Systems	0.0%	3.8%	7.5%	0.0%	0.0%	0.0%	0.0%	1.5%
NOx Reduction Systems	2.3%	0.4%	0.0%	0.0%	0.0%	0.0%	0.0%	1.3%
All Other Causes	15.3%	15.7%	15.1%	59.1%	18.9%	60.4%	29.9%	19.2%
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Should all of these be mapped to 1994 Weather conditions?

Source. Monitoring Analytics 2023 SOM