2024 RTO Membership Analysis
Appendix 12

ELCC Education

PC - ELCC Education Session

February 16 & 21, 2024

Acronyms

ELCC	Effective Load Carrying Capability
RRS	Reserve Requirement Study
LOLP	Loss-of-Load Probability
LOLE	Loss-of-Load Expectation (days / year)
LOLH	Loss-of-Load Hours (hours / year)
EUE	Expected Unserved Energy (MWh / year)
DR	Demand Resources
NOI	Binding Notice of Intent to offer submitted by market sellers
THI	Temperature Humidity Index
ENC	Effective Nameplate Capacity
ICAP	Installed Capacity
CIRs	Capacity Interconnection Rights
MFO	Maximum Facility Output

Education Sessions

- These sessions are intended to be educational for interested stakeholders on the ELCC analysis and capacity accreditation reforms recently approved in ER24-99
- High-level topics we plan to cover include:
  - An overview of the loss-of-load risk modeling used in the ELCC analysis (and RRS)
  - Walkthrough of the model inputs and simulated dispatch
  - Resulting patterns of system loss-of-load risk observed in the model
  - Marginal ELCC accreditation and performance adjustments
  - Changes between the preliminary and updated Feb. ELCC ratings that were published for 25/26
  - Posting of ELCC information
- Please ask questions. The purpose of these sessions is to facilitate market participants' understanding of the ELCC calculations and results.
  - Questions on the ELCC accreditation of specific resources can be sent to ELCC@pjm.com

Overview of Loss-of-Load Risk Model

Model Inputs

Weather Scenarios

Historical weather patterns captured back to 1993 (30 years)

Load Scenarios

Hourly load profiles derived from PJM's Load Forecast model for each historical weather scenario

- *Weather patterns shifted +/- 6 days to account for day of the week / holiday variables*

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*

Loss-of-Load Risk Modeling

System simulated under thousands of alternative scenarios to capture a broad range of potential system conditions and reliability outcomes.

30 Alternative Weather Years *
13 Alternative Load Scenarios *
100 Alternative Resource Performance Draws
= **39,000 Simulated Years**

Patterns of Risk

LOLE vs. LOLH vs EUE

- *Summer vs. winter? Morning vs. midday vs. evening? Long vs. short events? Deep vs. shallow?*

ELCC Ratings

Measure of resources' contribution to reliability given patterns of loss-of-load risk

Model Inputs and Simulated Dispatch

Weather Scenarios

- PJM purchases weather data from vendor (DTN)
- Historical weather patterns back to June 1, 1993 are used to derive the Weather Scenarios used in the loss-of-load risk analysis (ELCC/RRS studies)
- The Weather Scenarios are used in the model to:
  - Construct hourly load scenarios using latest PJM Load Forecast Model
  - Characterize historical resource performance as a function of temperature back to 2012 using a binning methodology
  - Capture the observed relationship that weather has on both load levels and resource availability in the simulated analysis

Notable Extreme Weather Days used in Model

Summer		
Date	HE	Temp.
July 15, 1995	15	97
July 21, 2011	15	95
July 5, 1999	17	96
Aug. 1, 2006	16	94

Winter		
Date	HE	Temp.
Jan. 19, 1994	8	-11
Jan. 7, 2014	7	-1
Feb. 20, 2015	8	-2
Dec. 23, 2022	23	5

Temp. columns reflects maximum or minimum hourly RTO-weighted average temperatures for the day

Load Scenarios

- Hourly load scenarios constructed from historical weather years using Load Forecast Model

- Weather rotations are applied where the historical weather is shifted 6 days forward and 6 days backward. This results in 12 additional load scenarios, or 13 in total, for each weather year providing **390 unique annual hourly load profiles** (30 weather years * 13 load scenarios)
  - Weather rotations allow the model to capture the fact that an extreme weather day that historically occurred on a weekend or holiday (e.g. Winter Storm Elliott) could potentially occur on a weekday where the resulting load profiles may be quite different (or vice versa). Example of rotations provided to the right.
  - Hourly load profiles published on Load Forecast Webpage

Forecast Date	Weather Date	Scenario
August, 9, 2024	August 3, 2010	M2010
August, 9, 2024	August 4, 2010	L2010
August, 9, 2024	August 5, 2010	K2010
August, 9, 2024	August 6, 2010	J2010
August, 9, 2024	August 7, 2010	I2010
August, 9, 2024	August 8, 2010	H2010
August, 9, 2024	August 9, 2010	A2010
August, 9, 2024	August 10, 2010	B2010
August, 9, 2024	August 11, 2010	C2010
August, 9, 2024	August 12, 2010	D2010
August, 9, 2024	August 13, 2010	E2010
August, 9, 2024	August 14, 2010	F2010
August, 9, 2024	August 15, 2010	G2010

shift weather 6 days backward

shift weather 6 days forward

- Load variability is modeled in the analysis to account for Load Forecast Error. When drawing the hourly load profiles from a load scenario for a day, the load is randomly sampled from a normal distribution with mean zero and standard deviation equal to approximately 1.2%.

Projected Resource Mix

The projected resource mix used in the ELCC/RRS risk modeling is based on:

1	**Existing Generation** Capacity Resources
2	**minus Generation Retirements** (based on submitted deactivation notices)
3	**plus Planned Generation Capacity Resources** (based on submitted NOIs and FRR plans)
4	**plus DR Forecast** (based on projected DR deployment in Load Forecast model)

Note: This approach to determine the projected resource mix reflects the new rules approved in ER24-99, which is different than what has been done in prior ELCC analysis (largely relied on vendor forecasts)

2025/26 Projected Resource Mix

ELCC Class	ENC	ICAP
Onshore Wind	11,957	2,405
Offshore Wind	*	*
Fixed-Tilt Solar	3,058	1,469
Tracking Solar	12,202	7,458
Landfill Intermittent	172	125
Hydro Intermittent	736	528
4-hr Storage	136	62
Pumped Hydro (includes 6, 8, and 10-hr Storage)	5,642	5,642
Hydro w/ Non-Pumped Storage	1,959	1,948
Hybrids	*	*

ELCC Class	ICAP
Nuclear	32,181
Coal	39,715
Gas Combined Cycle (includes single & dual fuel)	56,965
Gas Combustion Turbine	12,741
Gas Combustion Turbine Dual Fuel	13,322
Diesel Utility	461
Steam	7,497
Other Unlimited Resource	3,114
Demand Resource	7,814

** Certain class values excluded or merged for confidentiality*

*** ICAP reflects annual amount limited by annual CIRs (including awarded transitional CIRs)*

Resource Performance: Modeling Approach Overview

	Modeling Approach
Forced Outages and Ambient De-rates for Unlimited Resources	Historical weather and corresponding forced outages and ambient de-rates since June 1, 2012 used to characterize thermal outage rates as a function of weather based on a binning methodology
Variable Resource Availability	Historical weather and corresponding variable resource performance (actual and putative) since June 1, 2012 used to characterize performance as a function of weather based on a binning methodology
Planned & Maintenance Outages for Unlimited Resources	The amount (MW-weeks) of planned and maintenance outages per year based on historical data since June 1, 2012. Heuristic used to schedule planned and maintenance outages during periods of lower loads, except for small portion intentionally scheduled during high risk periods as observed since 2012.
Intermittent Hydro	Annual draw of performance since 2012 as a function of closest matching seasonal peak loads
Limited Duration Storage & Combination Resources	Simulated dispatch in the model that depends on other system conditions (e.g. load, other resources' performance, remaining storage) during the hour
Demand Resources	Simulated dispatch in the model where DR is deployed during hours within its defined performance windows when total available Unlimited and Variable Resources is less than the load

Resource Performance: History for Immature Units

- The modeled hourly output in the ELCC analysis and Resource Performance Adjustment calculations of Unlimited Resources and Variable Resources is based on performance data since June 1, 2012

- For resources that do not have a full performance history back to June 1, 2012 (“Immature Unit”), the following is used for each hour with missing data:
  - ***For Unlimited Resources:***
    - The putative forced outage history and ambient de-rate history of the resource will be calculated as total MW on forced outage or an ambient de-rate from resources in the same ELCC Class that were in operation at the time divided by total installed capacity of such resources.
    - Similarly, the putative planned/maintenance outage requirement of the resource will be derived using their share of the annual average planned/maintenance outage requirement of resources in the same ELCC Class.
  - ***For Variable Resources:***
    - The putative unavailability is derived from an hourly backcast, which uses geographical location and plant characteristics as inputs.

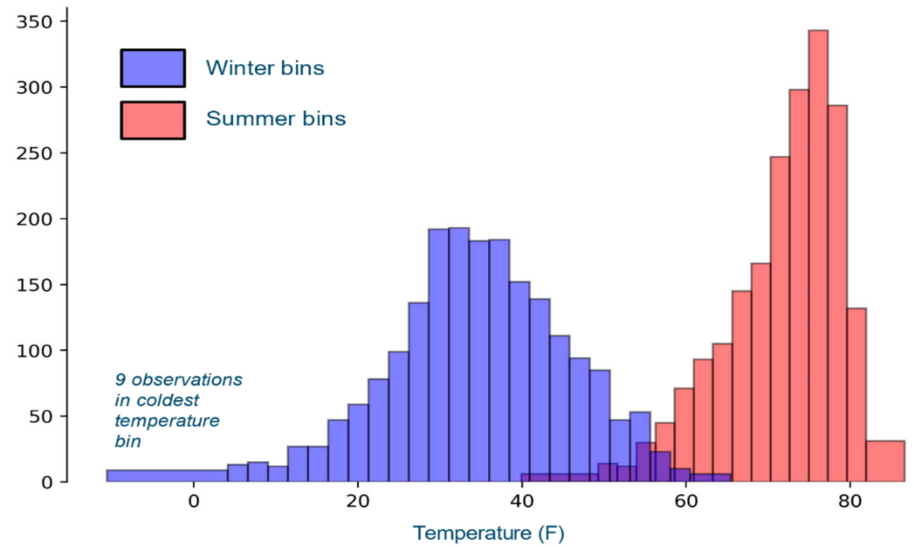
Resource Performance: Temperature Bins

A binning methodology is used as a means to mix and match (or “sample”) load and resource performance that occurred within similar weather conditions or “temperature bins.”

Temperature Binning Methodology

- Each historical day in the analysis is assigned to a temperature bin based on either (a) the minimum hourly RTO-wide THI for days in the winter, or (b) the maximum hourly RTO-wide THI for days in the summer
- The temperatures are grouped using binning methods (e.g. Freedman Diaconis Estimator method) employed in the development of histograms
- The historical days since June 1, 2012 and corresponding temperature bins form the “Resource Performance Bins” used to derive the 100 different resource performance patterns used in the analysis

Number of historical days within each temperature bin of Resource Performance Bins

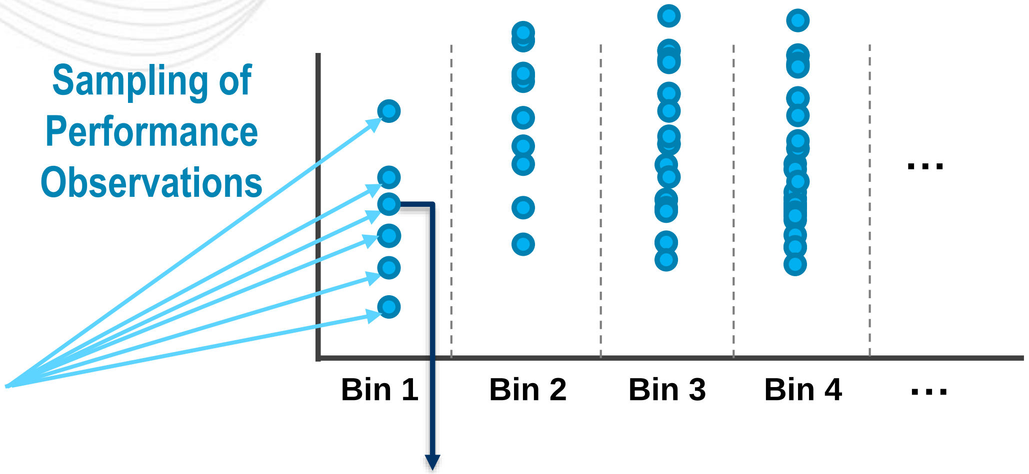


Resource Performance: Sampling from Temperature Bins

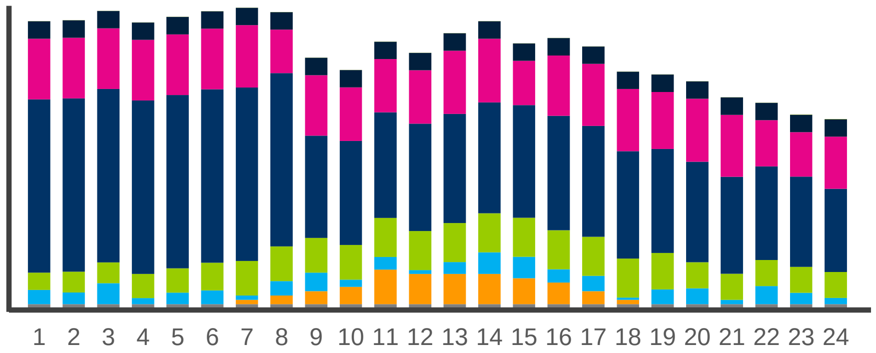
Weather Scenarios

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)

Winter Resource Performance Bins (Illustrative)



1 Sample Observation: Feb. X, 2015 Hourly Availability



Resource Performance: Deliverability Caps

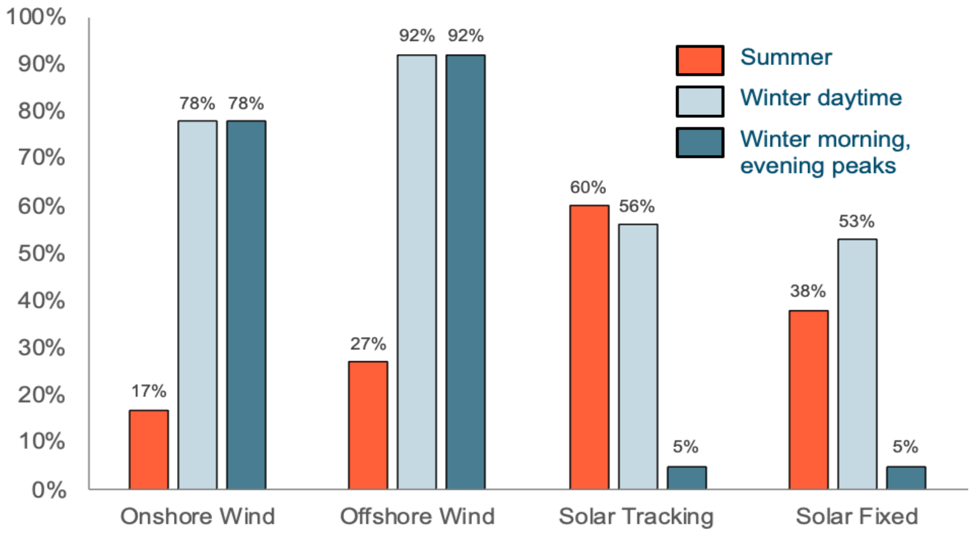
The modeled hourly output of resources in the ELCC analysis (and calculations of unit-specific performance adjustments) is limited to levels assessed in PJM deliverability studies

- For Unlimited and Limited Duration Resources, this is equal to CIRs year-round
- For Variable and Combination Resources, assessed deliverability levels can vary by season, resource type, and geographic location (i.e. PJM East, PJM West, PJM South)

Deliverability Caps	Unlimited Resources	Limited Duration	Variable & Combination
Summer	CIRs	CIRs	CIRs
Winter daytime	CIRs	CIRs	Assessed Deliverability
Winter morning & evening peaks	CIRs	CIRs	Assessed Deliverability

Note: *CIRs include any transitional CIRs that are awarded*

Avg. Deliverability Caps (across geographic locations) for Wind and Solar based on the resource's MFO



Resource Performance: Simulated Dispatch

- Less available resources are dispatched after the more available resources to maximize the system reliability benefit
  - If during a certain hour early on in the emergency event PJM has to choose between serving load with a more available resource (e.g., Demand Resource available for more than 10 hours) and serving load with a less available resource (e.g., a four-hour Limited Duration resource), PJM will dispatch the more available resource first

General Order of Dispatch in the Model:

Unlimited and Variable Resources → Demand Resources → Limited Duration Resources

Demand Resource Dispatch

- Demand Resources (DR) have performance windows depending on the season

	Capacity Performance DR	Summer-Period DR
Summer Months	10:00AM to 10:00PM EPT	10:00AM to 10:00PM EPT
Winter Months	6:00AM to 9:00PM EPT	NA

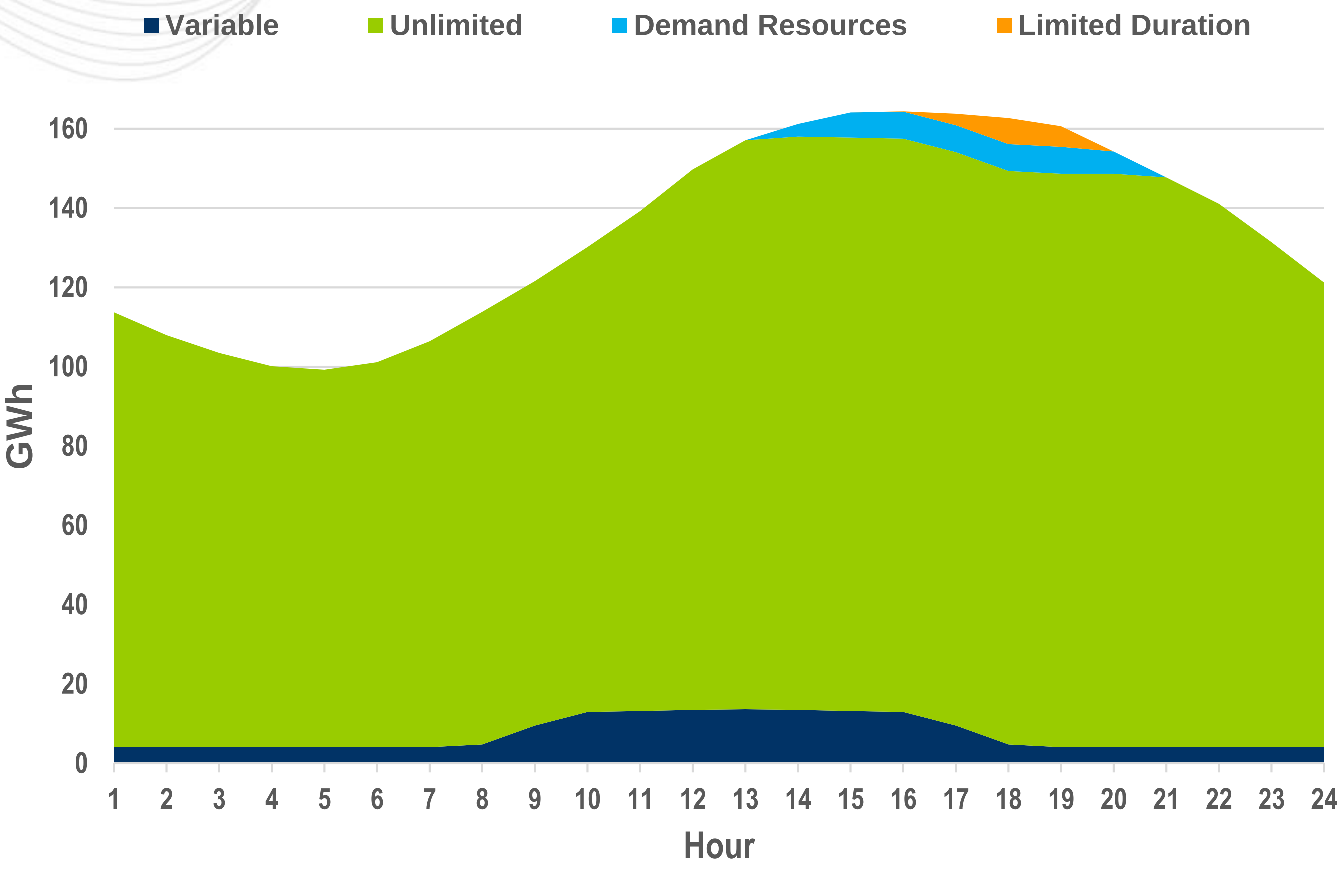
- DR is dispatched prior to limited duration resources, when available during the relevant performance window

- DR availability during performance window is modeled to be scaled proportional to system load.

$$\frac{Simulated\ HourlyLoad_i}{50/50\ Simulated\ Peak\ Load\ Forecast} \times Nominated\ ICAP\ of\ DR$$

Illustrative Day of Risk with Simulated Dispatch

- This figure shows an illustrative day with risk, and simulated dispatch to meet the load
- Demand Resources are dispatched prior to Limited Duration Resources, while respecting the Demand Resource performance window



Review of Model: Putting it Together

Model Inputs

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Load Scenarios

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Patterns of Risk

LOLE vs. LOLH vs EUE

- *Summer vs. winter? Morning vs. midday vs. evening? Long vs. short events? Deep vs. shallow?*

ELCC Ratings

Measure of resources' contribution to reliability given patterns of loss-of-load risk

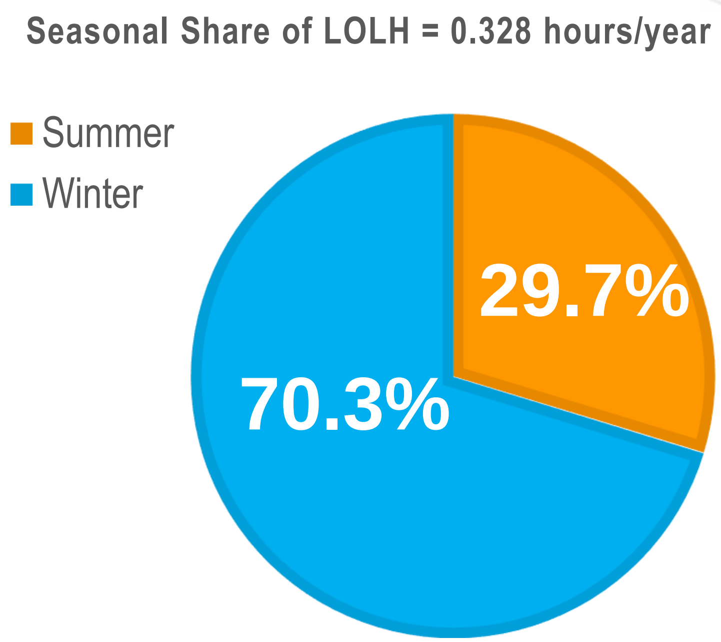
Patterns of Risk Observed in the Model

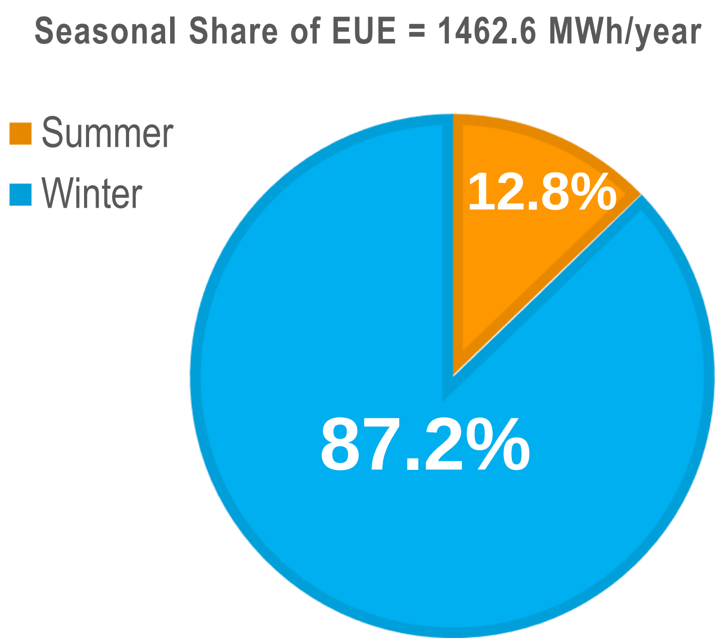
Patterns of Risk

- The broad range of potential system conditions that are simulated allow for the model to calculate a variety of statistical measures of resource adequacy
- These metrics provide insights into the expected frequency, size, and duration of expected unserved energy events based on the results of the simulation of thousands of years

Metric	Units	Description
LOLE	Days per year	Average number of days per year in which system demand exceeds available system supply (loss of load)
LOLH	Hours per year	Average number of hours per year with loss of load
EUE	MWh per year	Average total quantity of unserved energy per year during loss of load events

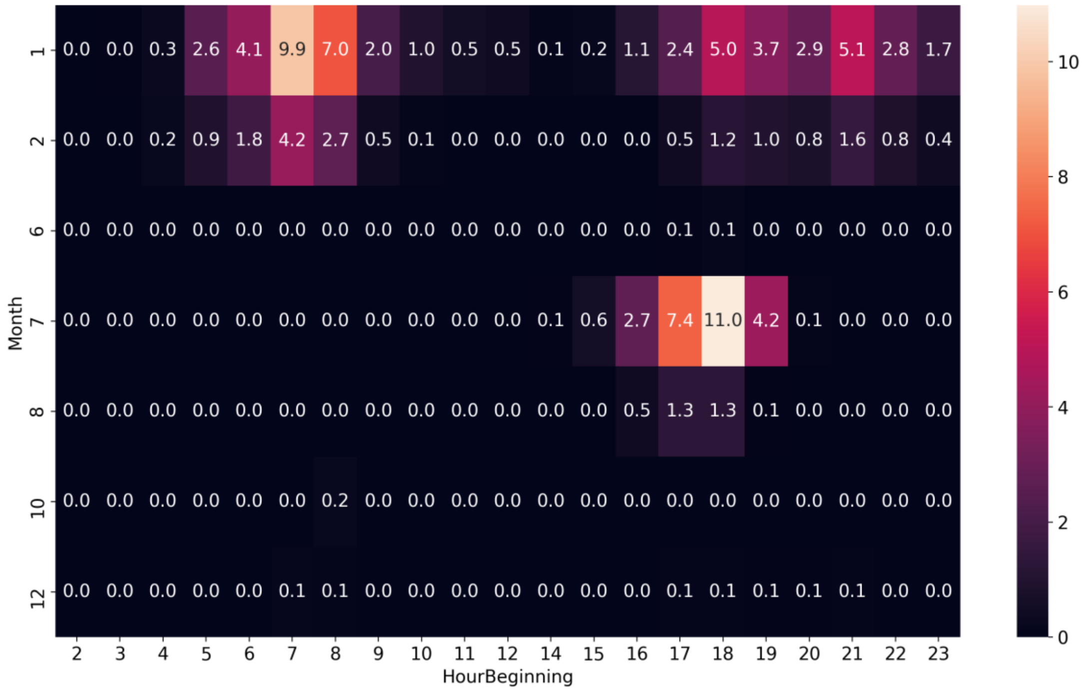
Feb. 2024 Results: Seasonal Share of LOLH and EUE



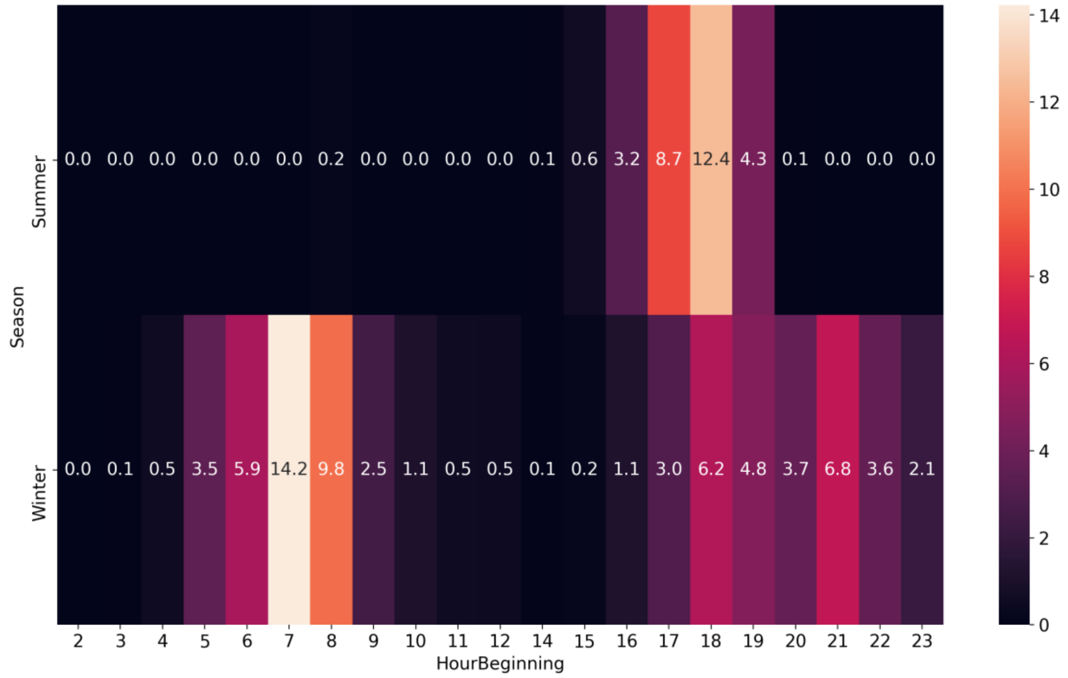


Feb. 2024 Results: LOLH Heatmaps

Month/Hour LOLH Heatmap

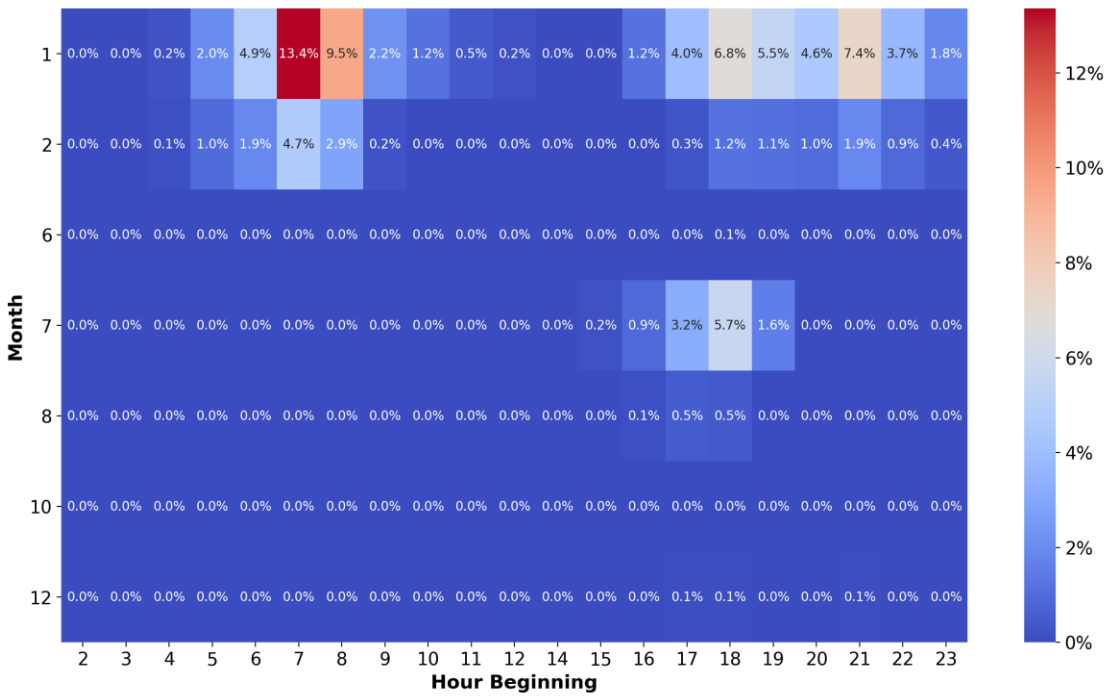


Season/Hour LOLH Heatmap

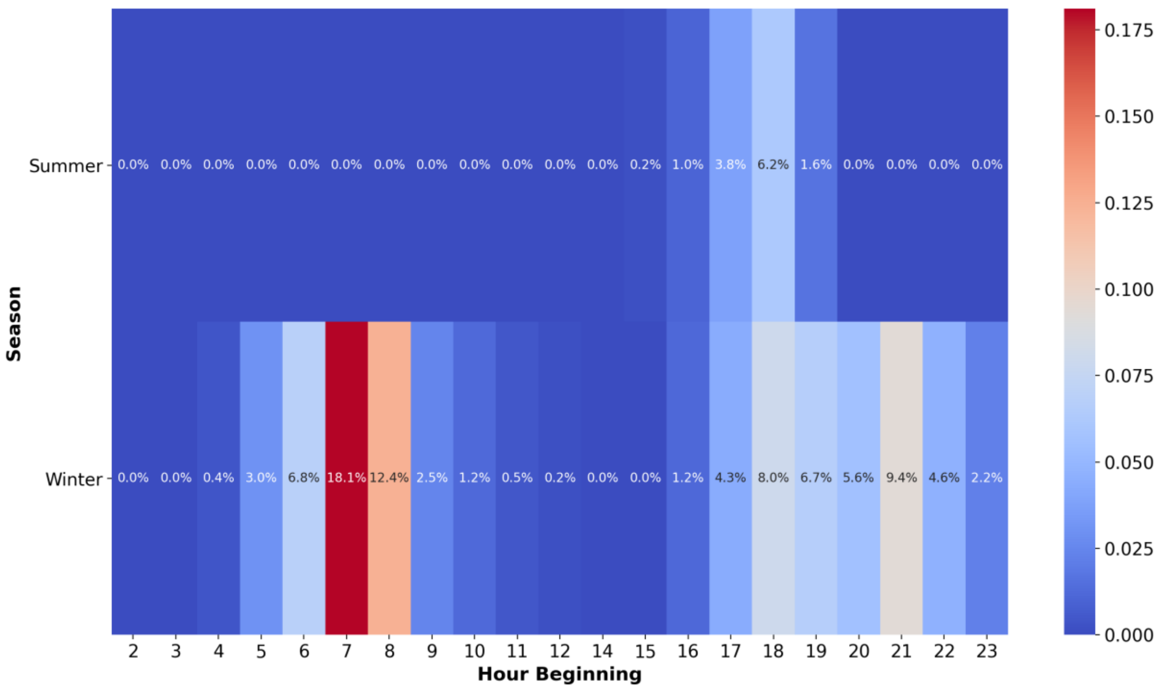


Feb. 2024 Results: EUE Heatmaps

Month/Hour EUE Heatmap



Season/Hour EUE Heatmap

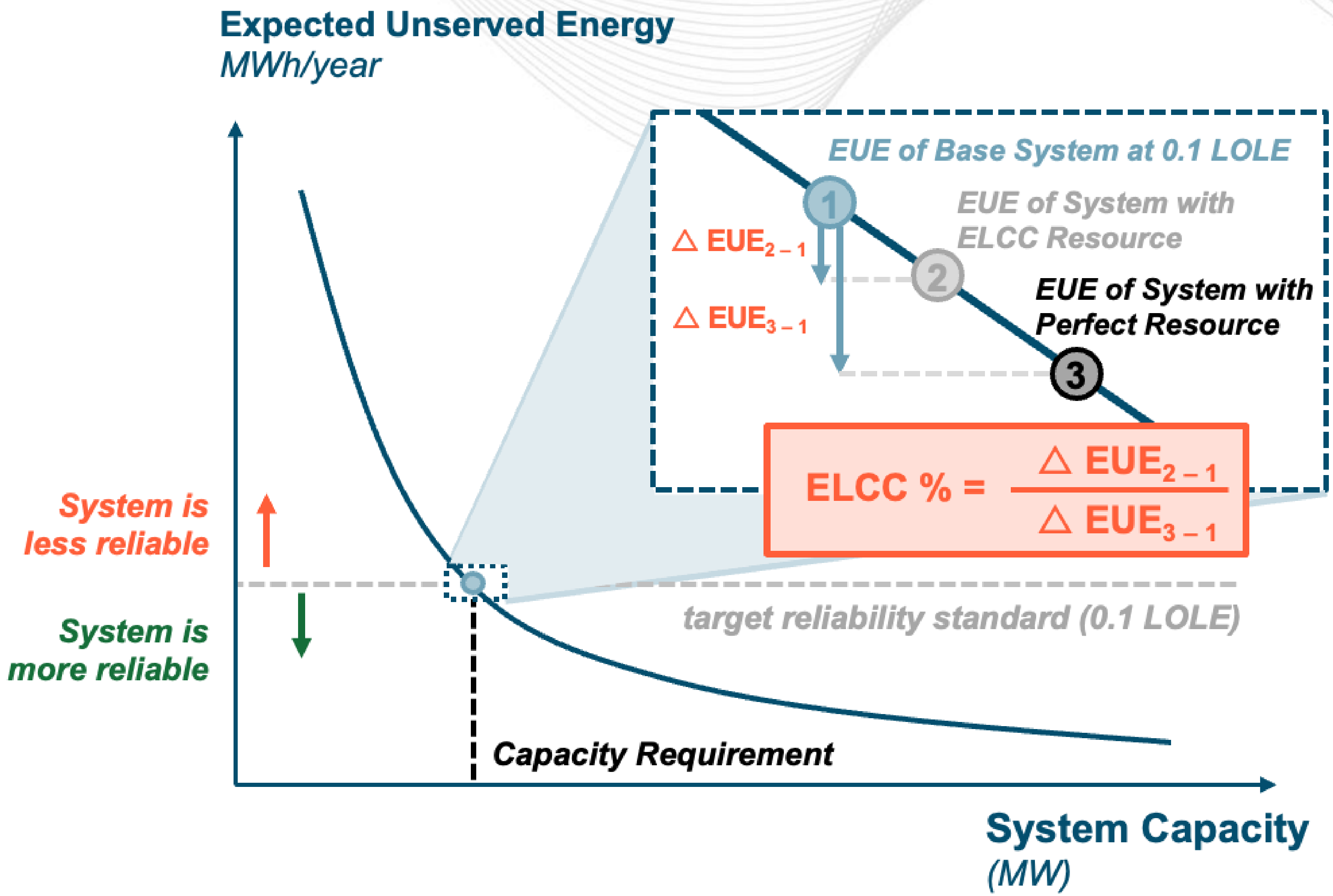


ELCC Accreditation

Methodology to Determine Marginal ELCC Class Ratings

	Methodology	Example: Application to "Class 1"
1.	Start with the expected resource mix and system at the annual target reliability criteria in the ELCC model	
2.	Add an increment of "perfect" annual capacity for the season under study	*Add 100 MW of 24x7 "perfect" capacity to the model*
3.	Run the risk model to determine reduction in EUE from adding the increment of "perfect" annual capacity	*Results show 50 MWh of EUE reduction*
4.	Replace the "perfect" capacity with the same amount of incremental capacity from the class under study	*Replace "perfect" capacity with equal ICAP of "Class 1"*
5.	Run the risk model and determine reduction in EUE from adding the increment of class capacity	*Results show 40 MWh of EUE reduction*
6.	Set the ELCC Class Rating based on the class EUE reduction relative to that of "perfect" capacity	*"Class 1" Rating = 40 MWh / 50 MWh =* ***80%*** *"Class 1" ELCC*

Illustration of the Marginal ELCC Class Rating Methodology

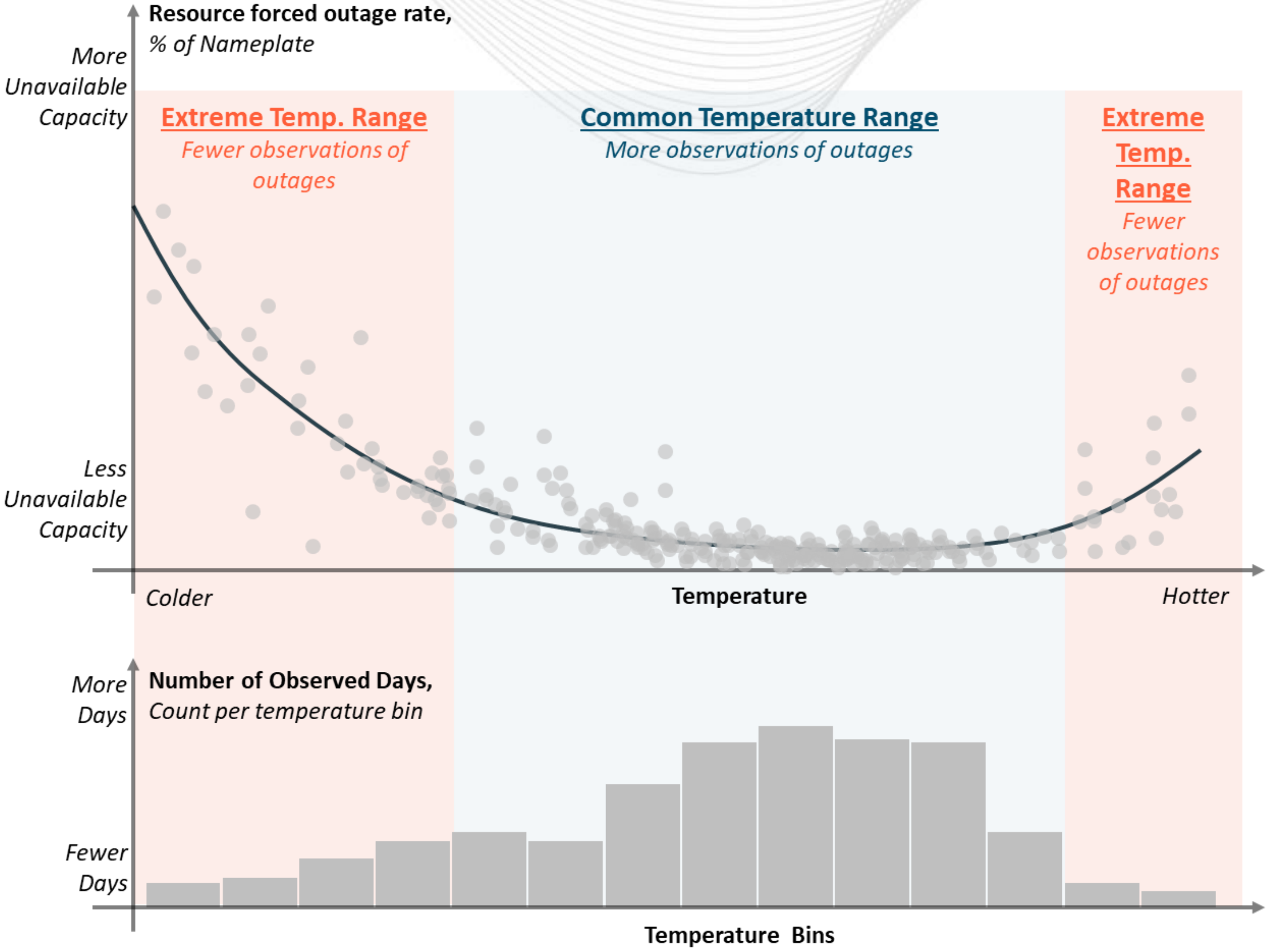


Connection b/w Patterns of Risk, Performance, and ELCC

Scenarios	Variable	Hours (assume 10 hours in year)										Annual Totals
Scenario 00001	Risk in hour	0	0	1	1	1	0	0	0	1	0	4 hours of risk in scenario 00001
	Output from increment of perfect ICAP	1	1	1	1	1	1	1	1	1	1	400 MWh reduction in unserved energy, perfect resource
	Output from increment of class ICAP	1	.5	.5	.7	.8	1	.9	.9	1	1	300 MWh reduction in unserved energy, incremental class ICAP
Scenario 00002	Risk in hour	0	0	0	0	0	0	0	0	0	0	0 hours of risk in scenario 00002
	Output from increment of perfect ICAP	1	1	1	1	1	1	1	1	1	1	0 MWh reduction in unserved energy, perfect resource
	Output from increment of class ICAP	1	.6	.6	.8	.9	1	.9	.9	1	1	0 MWh reduction in unserved energy, incremental class ICAP
⋮		⋮										⋮
Scenario 39000	Risk in hour	0	0	1	0	0	0	0	0	0	0	1 hour of risk in scenario 39000
	Output from increment of perfect ICAP	1	1	1	1	1	1	1	1	1	1	100 MWh reduction in unserved energy, perfect resource
	Output from increment of class ICAP	1	1	1	.5	.5	1	1	1	.5	1	100 MWh reduction in unserved energy, incremental class ICAP
Totals												0.5 hours of risk on average 50 MWh reduction in unserved energy, perfect resource 40 MWh reduction in unserved energy, incremental class ICAP

$$\frac{\textbf{40 MWh}}{\textbf{50 MWh}} = \textbf{80\% Class Average ELCC}$$

Illustrative Distribution of Resource Forced Outage Observations



Relative Weighting of Historical Performance in Class ELCC

- Table at right reports the relative frequency at which different historical performance days are represented among all hours in which loss of load is observed in the risk simulation model
  - For example: class and fleet performance data reflects that which was observed on December 24, 2022 in 10.8% of all hours with loss of load observed in the simulation
  - Class performance on most heavily weighted days affects ELCC Class Rating most strongly

Date			Weight
7	Jan	2014	44.1%
24	Dec	2022	10.8%
8	Jan	2014	4.5%
28	Jan	2014	3.0%
22	Jan	2014	2.6%
26	Dec	2022	1.8%
18	Jul	2012	1.7%
25	Dec	2022	1.2%
17	Jul	2012	1.1%
29	Jun	2012	0.8%
31	Jan	2019	0.7%
23	Dec	2022	0.5%
25	Jul	2016	0.4%
29	Jun	2021	0.4%
18	Jul	2013	0.4%
19	Jul	2012	0.4%
25	Aug	2020	0.4%
23	Jan	2013	0.3%
17	Jul	2013	0.3%
7	Jul	2012	0.3%
...	...	...	...

ELCC Resource Performance Adjustment

Summary: ELCC resource performance adjustment factor reflects each resources' average historically-observed performance, in those hours and weather conditions (temperature bins) in which the system experiences reliability risk, relative to class average historically-observed performance in those same hours and weather conditions

Details of computation:

- For each temperature bin *(b)* and hour of day *(h)*:
  - Calculate unit's *(u)* average availability across all observations in that bin & hour: A_{ubh}
  - Calculate class's *(c)* average availability across all observations in that bin & hour: A_{cbh}
  - Calculate relative risk weighting of the bin & hour (as a share of total risk): R_{bh}
- Compute weighted average of unit availability across all bin/hour pairs: $A_u = \sum_{b,h} R_{bh} \cdot A_{ubh}$
- Compute weighted average of class availability across all bin/hour pairs: $A_c = \sum_{b,h} R_{bh} \cdot A_{cbh}$
- Compute Resource Performance Adjustment: $RPA_u = \frac{A_u}{A_c}$

ELCC Unit-Specific Performance Adjustment: Example

Bin b	Hour of day h	Weight R_{bh}	Unit's average availability A_{ubh}	Class's average availability A_{cbh}
winter1	1	0	0.98	0.80
winter1	**2**	**0.3**	**0.95**	**1.00**
winter1	**3**	**0.2**	**0.95**	**0.89**
⋮	⋮	⋮	⋮	⋮
winter1	24	0	0.84	0.99
winter2	1	0	0.89	0.91
winter2	**2**	**0.2**	**0.98**	**0.81**
winter2	3	0	0.95	0.90
⋮	⋮	⋮	⋮	⋮
winter2	24	0	0.92	0.99
winter3	1	0	0.88	0.87
winter3	2	0	0.85	0.90
winter3	3	0	0.96	0.95
⋮	⋮	⋮	⋮	⋮
winter3	24	0	0.94	0.96
⋮	⋮	⋮	⋮	⋮
summer34	1	0	0.98	0.89
summer34	2	0	0.96	0.89
summer34	**3**	**0.3**	**0.99**	**0.96**
⋮	⋮	⋮	⋮	⋮
summer34	24	0	0.95	0.94
Weighted Averages			0.97	0.93
Resource Performance Adjustment				**1.04**

Computation Reference:

- For each temperature bin *(b)* & hour of day *(h)*:
  - Unit's *(u)* average availability across all observations in that bin & hour: A_{ubh}
  - Class's *(c)* average availability across all observations in that bin & hour: A_{cbh}
  - Relative risk weighting of the bin & hour (as a share of total risk): R_{bh}
- Weighted average of unit availability across all bin/hour pairs:

$$A_u = \sum_{b,h} R_{bh} \cdot A_{ubh}$$

- Weighted average of class availability across all bin/hour pairs:

$$A_c = \sum_{b,h} R_{bh} \cdot A_{cbh}$$

- Resource Performance Adjustment: $\frac{A_u}{A_c}$

Putting all the pieces together: Resource UCAP Calculations

- **Unlimited Resources**: Resource ICAP × ELCC Class Rating × Resource Performance Adjustment
- **Variable & Limited Duration Resources**: *min* { Effective Nameplate Capacity × ELCC Class Rating × Resource Performance Adjustment, Resource ICAP (CIR level) }
- **Demand Resource**: Resource ICAP (Nominated Value) × ELCC Class Rating

- **Examples**
  - SolarTracking1 UCAP: min { 100 MW × 0.14 × 0.9, 60 MW } = 12.6 MW UCAP
  - OnshoreWind2 UCAP: min { 100 MW × 0.35 × 0.9, 30 MW } = 30 MW UCAP
  - Nuclear3 UCAP: 1,000 MW × 0.96 × 0.9 = 864 MW UCAP
  - Demand4 UCAP: 100 MW × 0.77 = 77 MW UCAP

Note 1: All resources can request transitional CIRs, which can increase annual ICAP.
Note 2: Wind resources can request winter CIRs on a year-to-year basis, which can increase winter CIRs and ICAP.

Preliminary and Updated ELCC Class Ratings Published for the 25/26 BRA

Preliminary and Updated ELCC Class Ratings

ELCC Class	Prelim Ratings	Feb. 2024 Ratings	Change (in %)
Onshore Wind	21%	35%	14%
Offshore Wind	39%	60%	21%
Solar Fixed Panel	15%	9%	-6%
Solar Tracking Panel	25%	14%	-11%
Landfill Gas Intermittent	56%	55%	-1%
Hydro Intermittent	41%	36%	-5%
4-hr Storage	76%	59%	-17%
6-hr Storage	85%	67%	-18%
8-hr Storage	89%	69%	-20%
10-hr Storage	92%	78%	-14%
DR	95%	77%	-18%
Nuclear	96%	96%	0%
Coal	86%	85%	-1%
Gas CC	87%	80%	-7%
Gas CT	74%	62%	-12%
Gas CT Dual Fuel	90%	78%	-12%
Diesel	91%	90%	-1%
Steam	78%	70%	-8%

- **Increase** in ELCC ratings for **wind** units
- **Decrease** for **solar, storage, DR and gas** units

Inputs that Changed b/w Prelim and Updated Values

1. Updated Load Forecast

Load forecast updated for Feb. 2024 ELCC values using 2024 forecast rather than 2023. 2024 Load Forecast saw higher winter loads relative to summer peak than 2023, which increased the share of winter risk in the model.

Load Forecast Report	50/50 Summer Peak	50/50 Winter Peak	90/10 Summer Peak	90/10 Winter Peak
2023	150,924	135,094	165,163	144,493
2024	153,493	139,224	167,798	148,095
Delta	2569	4,130	2635	3602

Winter Peak Load Forecast increased by **1000 - 1500 MW** more than Summer Peak Load Forecast increased

2. Updated Projected Resource Mix

Projected resource mix updated based on new rules considering existing units, retirements, and binding notices to offer of planned units. The projected resource mix for the preliminary ELCC values were based on latest vendor forecast at the time (December 2022).

The table below shows the classes that had the relatively larger changes in forecasted levels. The jump in solar forecast and drop in wind all contributed to further increasing the share of winter risk in the model.

ELCC Classes w/ Large Changes	Nameplate Delta
Wind Classes (Onshore, Offshore)	~ -6500
Solar Classes (Fixed Panel, Tracking Panel)	~ +3000

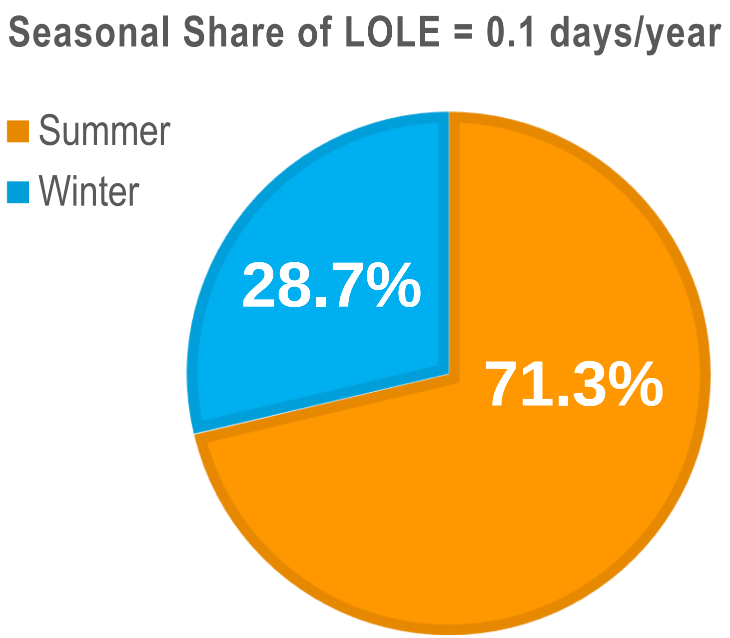
Sensitivities on Feb. 2024 ELCC Results

ELCC Runs	EUE	LOLH	LOLE
Feb. 2024 Results	W:87% S:13%	W:70% S:30%	W:55% S:45%
Sensitivity 1: Revert back to 2023 load forecast rather than 2024	W:79% S:21%	W:59% S:41%	W:46% S:54%
Sensitivity 2: Same as Sensitivity 1, plus using prior resource mix based on vendor projections	W:57% S:43%	W:38% S:62%	W:30% S:70%

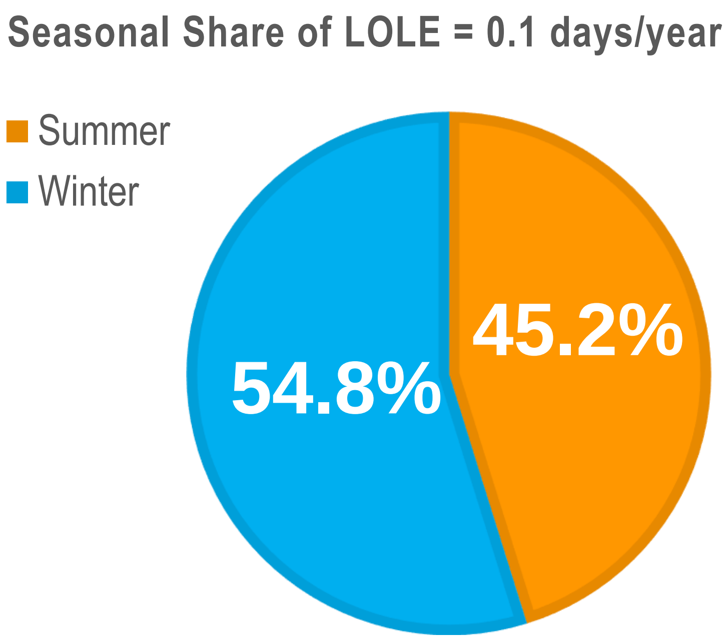
Combined effect of the load forecast update and resource mix changes had a substantial impact on seasonal risk patterns which drove the changes in accredited values for resource classes, particularly for those that have significantly different performance in summer vs. winter (e.g. wind / solar / gas)

Seasonal Changes in 25/26 LOLE

Preliminary Results



February 2024 Results



Changes in Key Historical Weather Days Contribution to 25/26 LOLE

Preliminary Results

Weather Day	LOLE
7/21/2011	0.0035
7/16/2011	0.0034
7/17/2011	0.0033
7/23/2011	0.0032
8/7/2006	0.0030
1/15/1994	0.0029
1/16/1994	0.0029
7/29/2006	0.0028
7/18/2011	0.0025
7/15/2011	0.0025
7/24/2011	0.0025
8/4/2006	0.0025
7/8/1995	0.0023
7/15/1995	0.0023
7/17/1995	0.0023
7/30/2006	0.0022
7/22/2011	0.0022
1/21/1994	0.0022
7/10/1995	0.0022
1/20/1994	0.0021

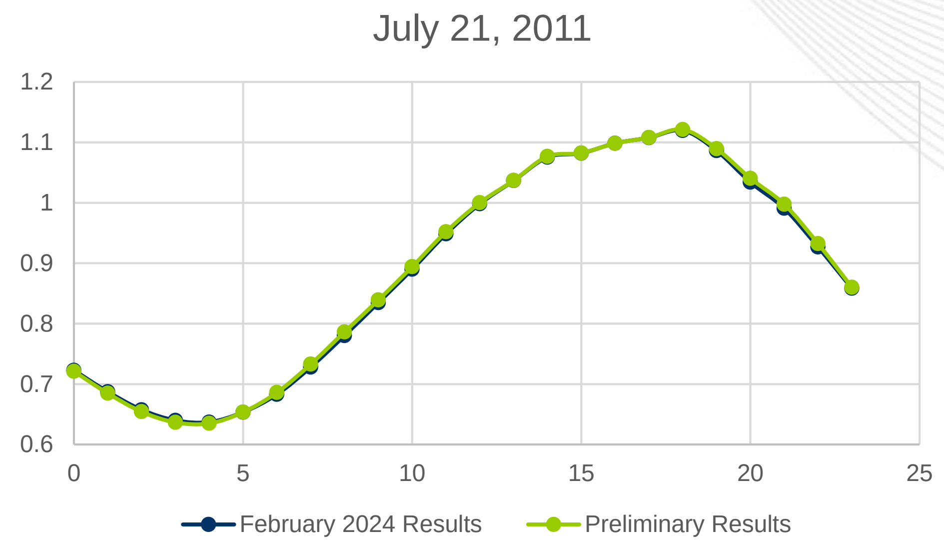
- About 50% of the LOLE is concentrated in 20 weather days. 16 in the summer and 4 in the winter.

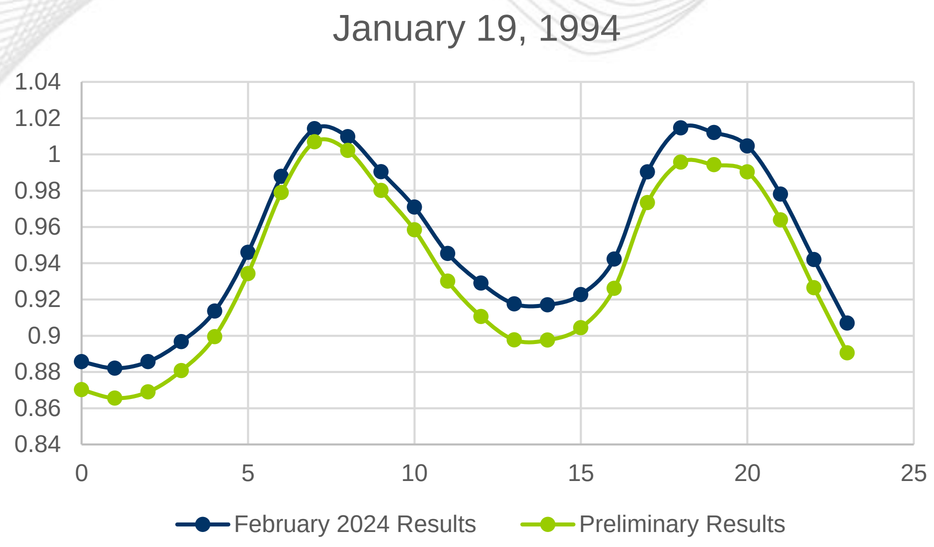
Feb. 2024 Results

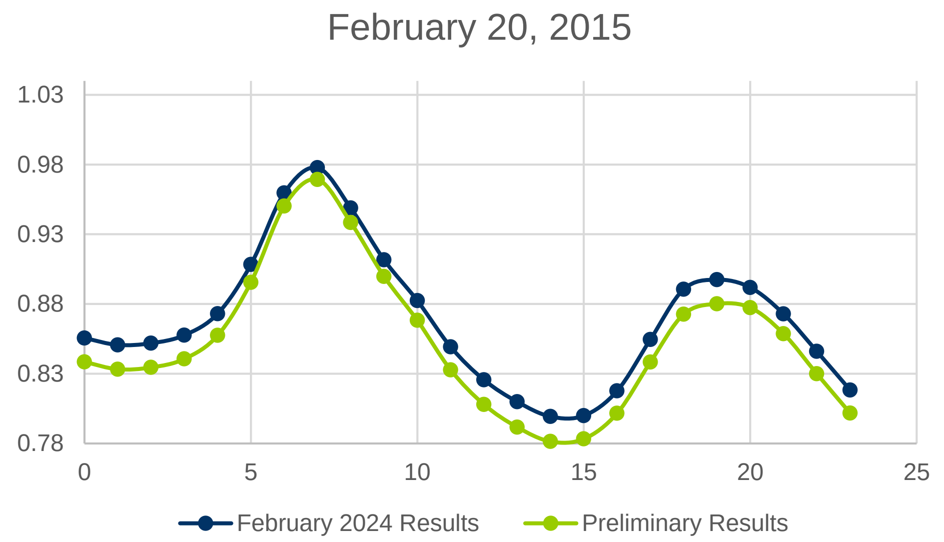
Weather Day	LOLE
1/21/1994	0.0044
1/15/1994	0.0040
2/19/2015	0.0035
1/20/1994	0.0032
1/16/1994	0.0031
7/17/2011	0.0028
1/19/1994	0.0028
7/21/2011	0.0026
1/28/2014	0.0025
7/15/2011	0.0024
7/29/2006	0.0024
7/23/2011	0.0023
1/6/2018	0.0023
7/16/2011	0.0023
1/7/2018	0.0022
2/20/2015	0.0022
7/18/2011	0.0021
2/24/2015	0.0020
7/8/1995	0.0020
7/17/1995	0.0019

- About 50% of the LOLE is concentrated in 20 weather days. 9 in the summer and 11 in the winter.

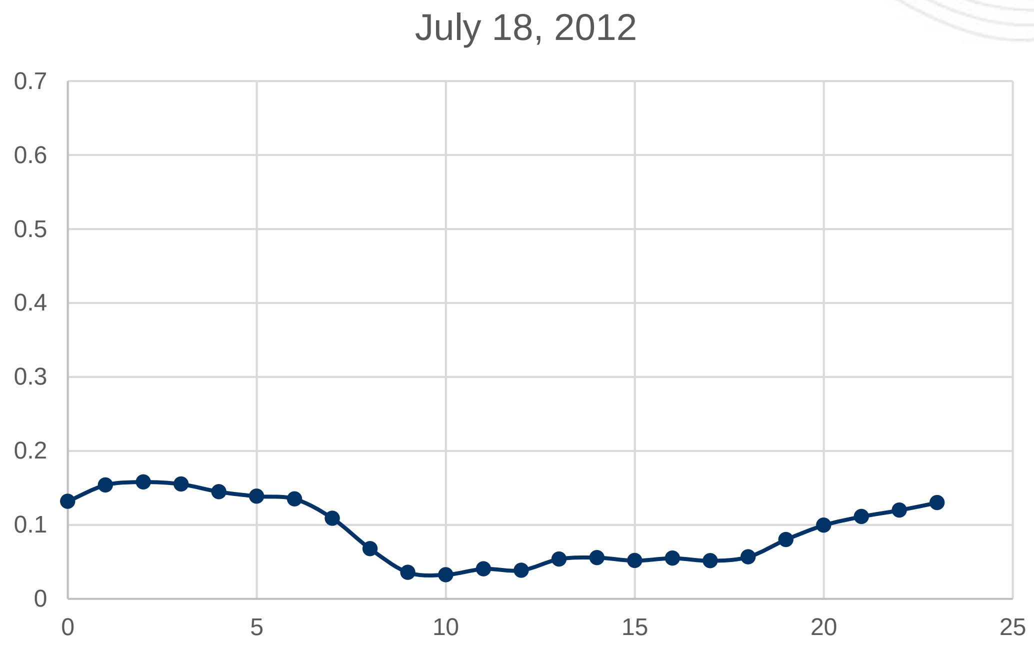
Changes in Forecasted Load during some Key Historical Weather Days

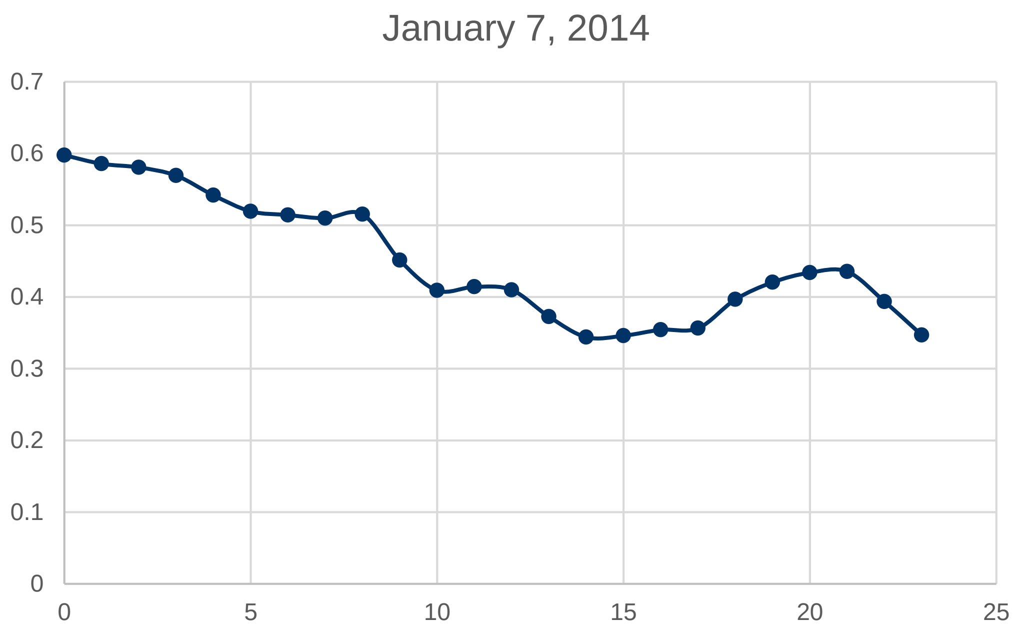




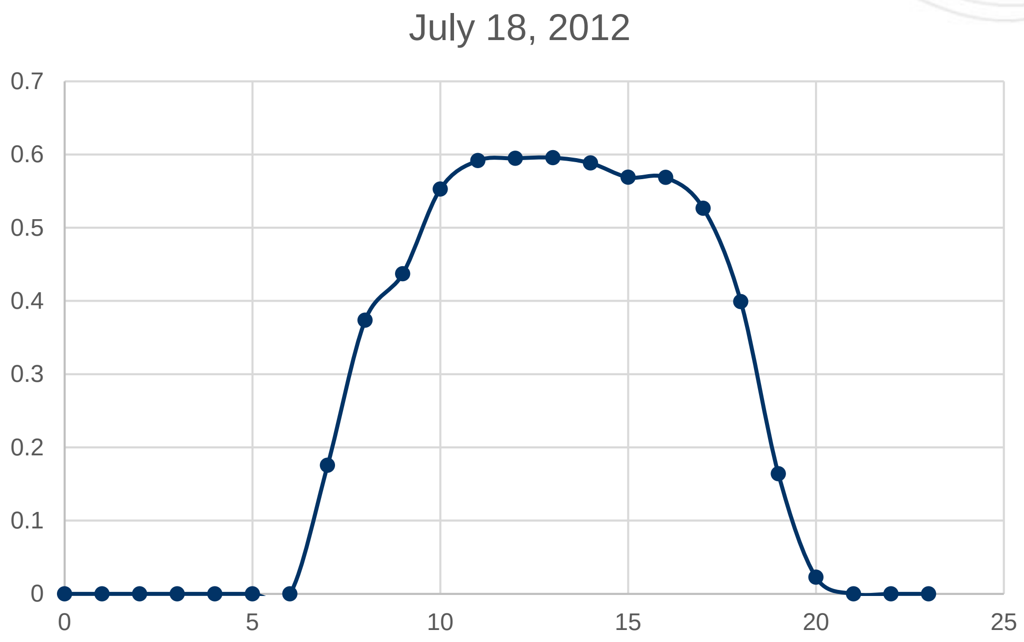


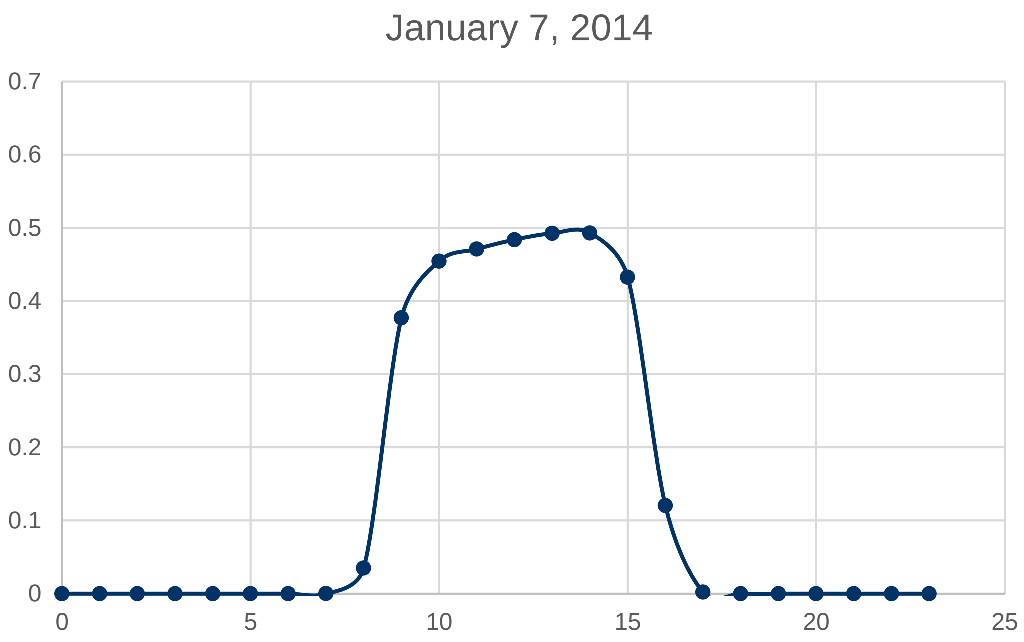
Onshore Wind Percent of Nameplate Output on Key Performance Days





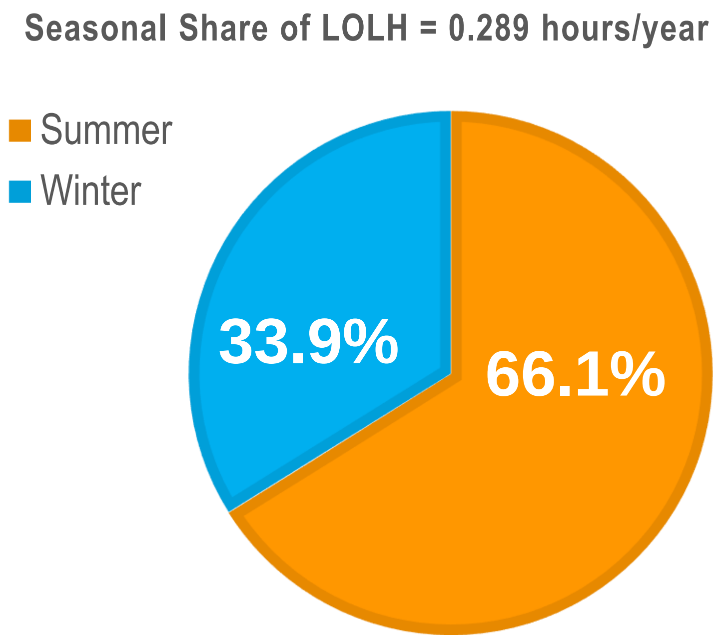
Solar Tracking Percent of Nameplate Output on Key Performance Days



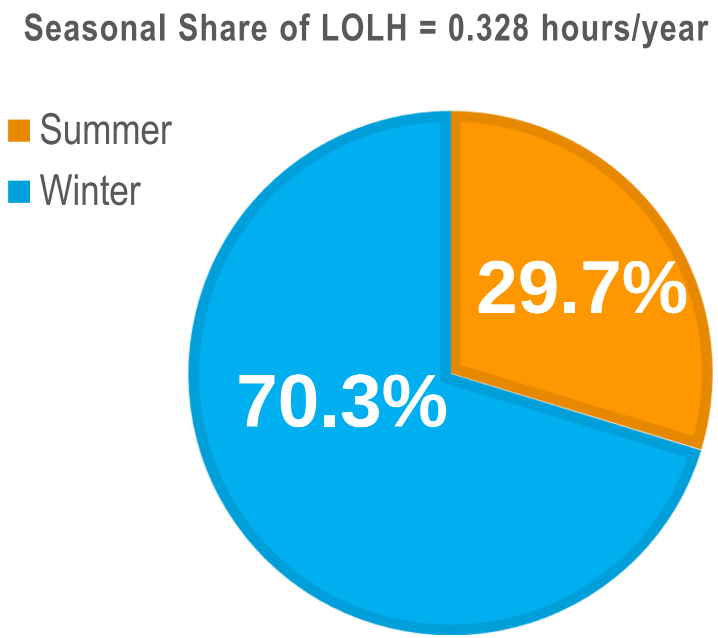


Seasonal Changes in 25/26 LOLH

Preliminary Results

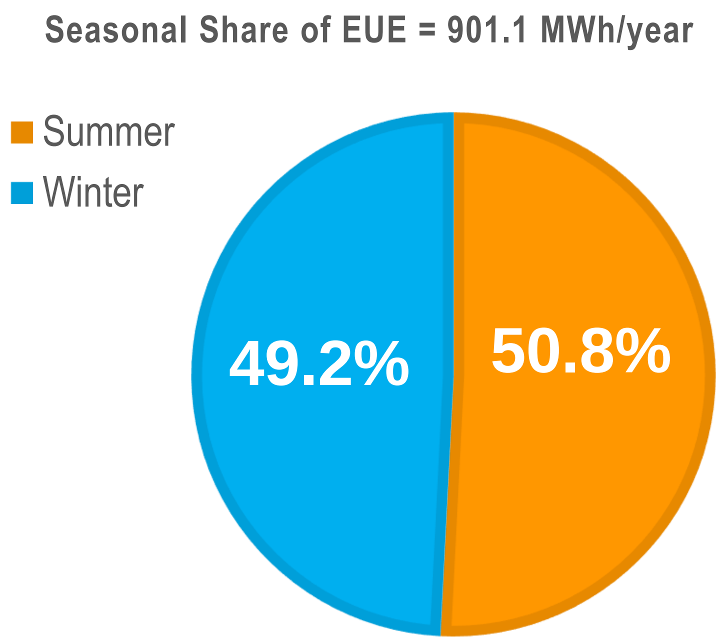


February 2024 Results

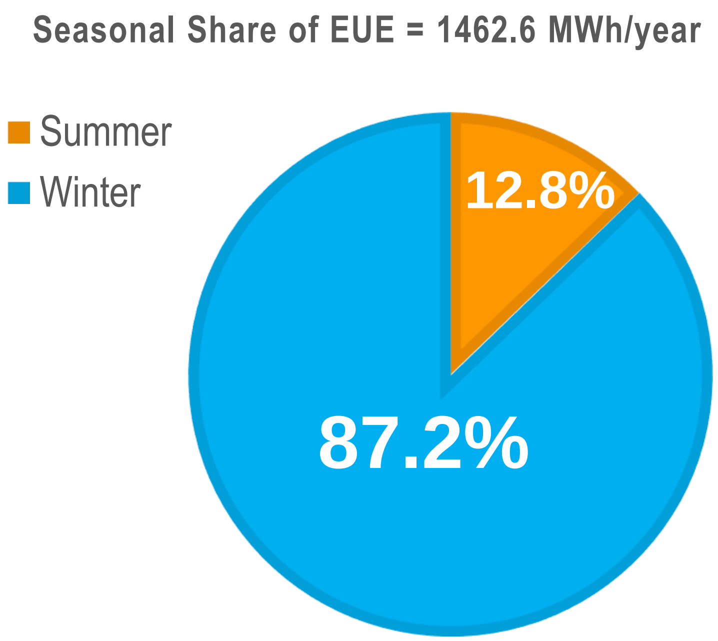


Seasonal Changes in 25/26 EUE

Preliminary Results

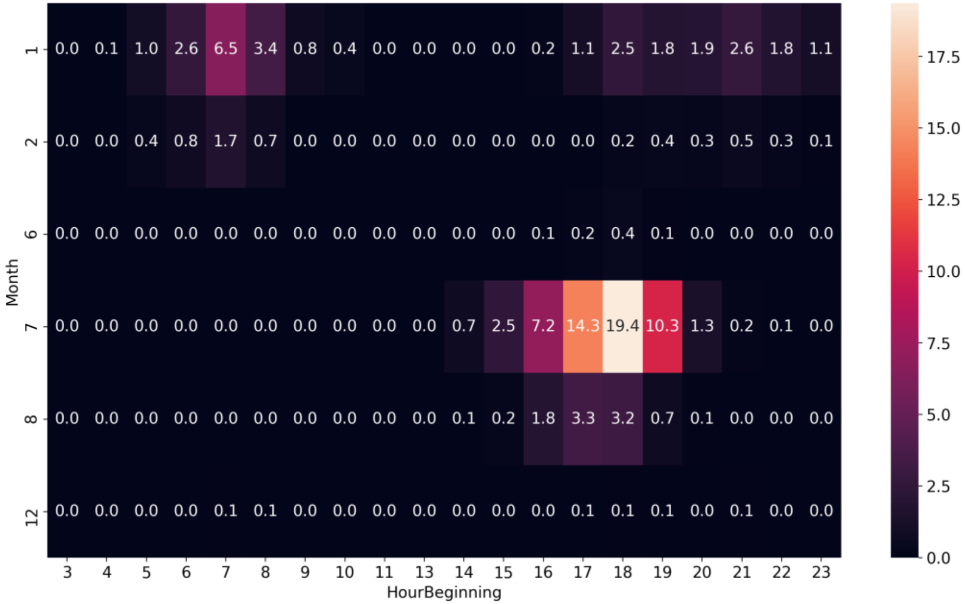


February 2024 Results

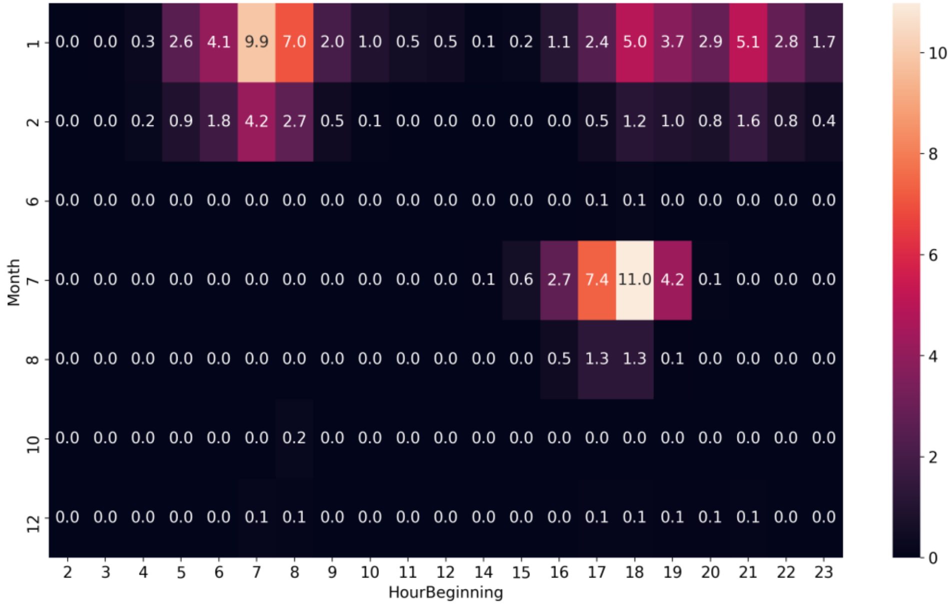


25/26 LOLH Month/Hour Heatmap Changes

Preliminary Results

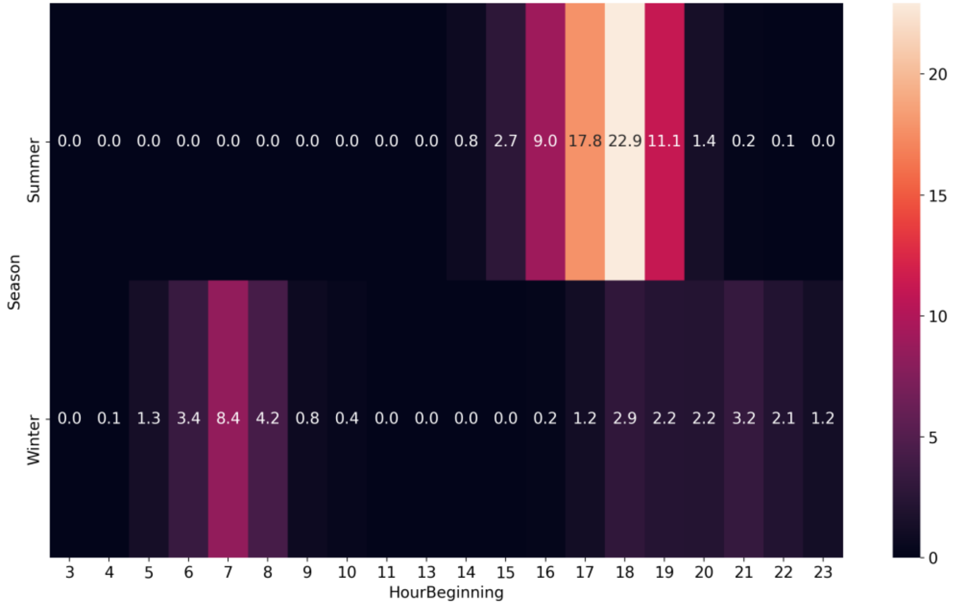


February 2024 Results



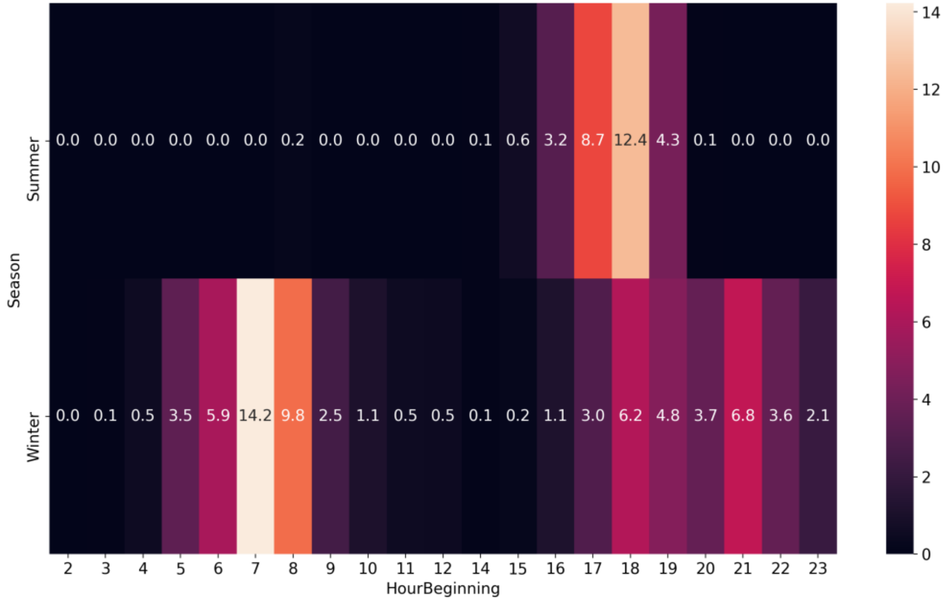
25/26 LOLH Season/Hour Heatmap Changes

Preliminary Results



Percent of LOLH in Hours where DR is not available:
0.1 (Summer) + 7.9 (Winter) = 8.0%

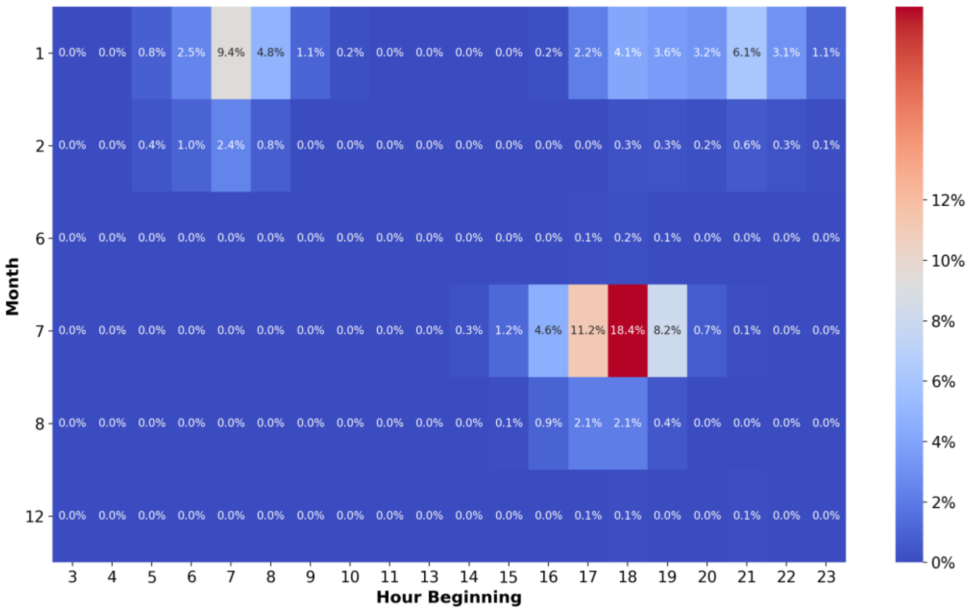
February 2024 Results



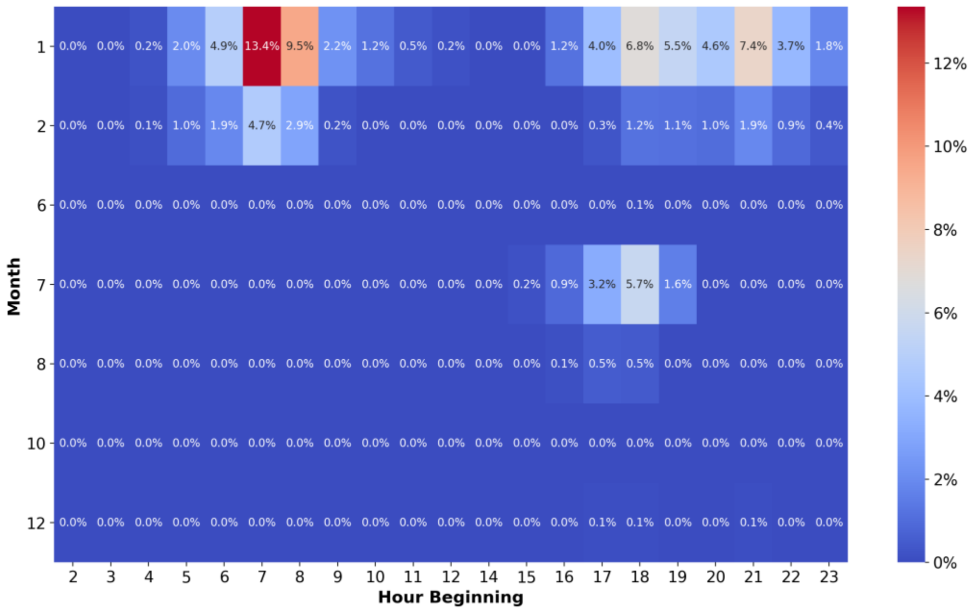
Percent of LOLH in Hours where DR is not available:
0.2 (Summer) + 15.6 (Winter) = 15.8%

25/26 EUE Month/Hour Heatmap Changes

Preliminary Results

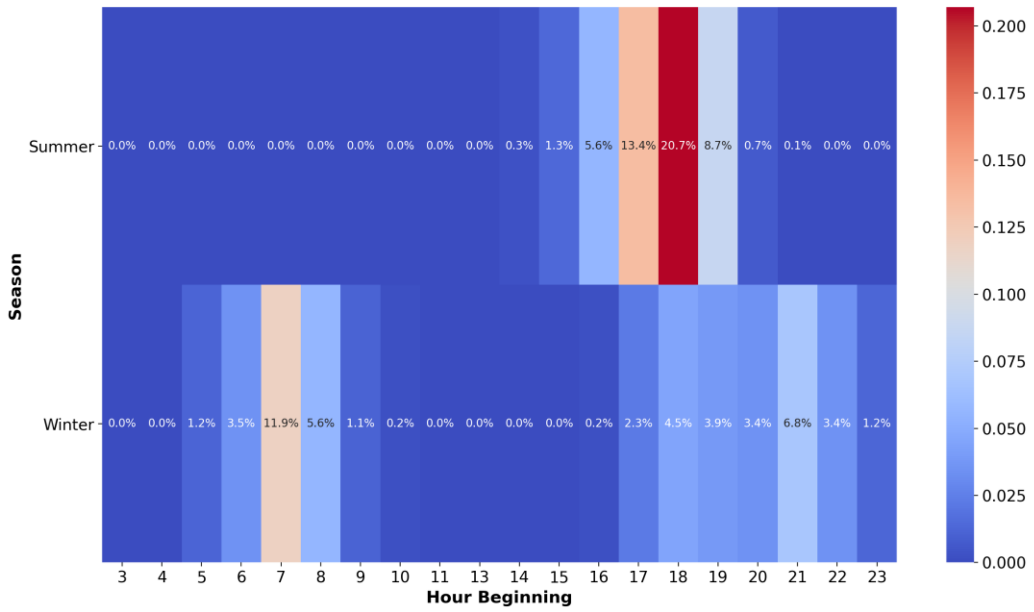


February 2024 Results



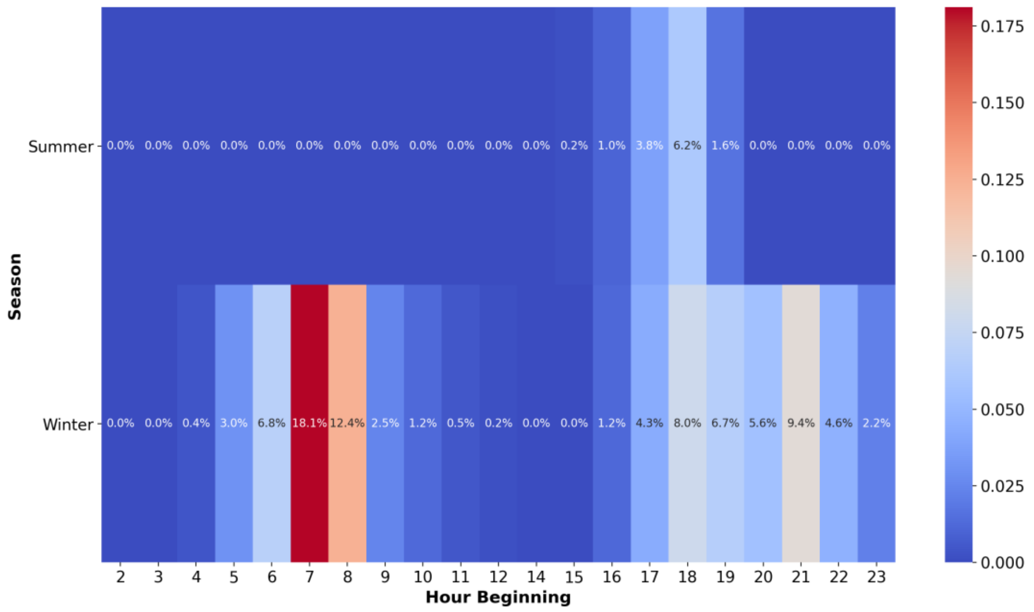
25/26 EUE Season/Hour Heatmap Changes

Preliminary Results



Percent of EUE in Hours where DR is not available:
0.0 (Summer) + 12.6 (Winter) = 12.6%

February 2024 Results



Percent of EUE in Hours where DR is not available:
0.0 (Summer) + 19.6 (Winter) = 19.6%

25/26 Changes in Number of Hours with Loss of Load per Day

Preliminary Results

Season	Mean	StDev	Min	25th Perc	Median	75th Perc	Max
Summer	2.7	1.5	1	1	2	4	9
Winter	3.4	3.2	1	1	2	4	15

February 2024 Results

Season	Mean	StDev	Min	25th Perc	Median	75th Perc	Max
Summer	2.2	1.2	1	1	2	3	7
Winter	4.2	3.9	1	1	3	6	20

Posting of ELCC Information

ELCC Model Information to be Posted

Information on Model Inputs	Information on Model Outputs
Hourly time series starting on June 1, 2012 of per unitized output for each Variable class	Simulated Dispatch of Demand Resources class, Limited Duration Resources class, and Combination Resource class in hours with Loss of Load
Hourly time series starting on June 1, 2012 of forced outage rates and ambient de-rates for each Unlimited class	Date / time, and amount of unserved energy for each hour with loss of load in the model
Planned and Maintenance Outage Schedules for Unlimited Class for each scenario	Performance Adjustment ranges within ELCC Classes
Temperature bins, and historical days in each bin	Actual Performance date / time of each hour with loss of load
Projected resource mix used in the model	
Hourly load profiles derived from Load Forecast Model	

- Informational ELCC Class Ratings for years beyond 2025/26

Contact

SME/Presenter:

Patricio Rocha Garrido,
Patricio.Rocha-Garrido@pjm.com

PC - ELCC Education Session

Member Hotline

(610) 666 – 8980

(866) 400 – 8980

custsvc@pjm.com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