DR Availability Window:
PJM Solution Options

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Today's Presentation

- Briefly review PJM solution options presented at Oct/Nov MIC
- Review results of ELCC sensitivity analyses that reflect changes to the DR modeling to incorporate the proposed PJM solution options
- Discuss added solution option related to DR performance compliance for stakeholder consideration and feedback

Background: DR Nominated Value and ICAP

For Firm Service Level (FSL) customers, Nominated Value and ICAP are based on the difference between customer's Peak Load and FSL in each season

Summer Nominated Value = PLC – SFSL (adjusted for loss factor)

- Peak Load Contribution (PLC) = customer's load usage during PJM system 5 summer coincident peak days and hours (EDC-specific calculation)
- Summer Firm Service Level (SFSL) = pre-defined level for which a customer's load can be reduced to when dispatched in the summer

Example:
PLC = 10 MW
SFSL = 0 MW
Summer Nominated Value = 10 MW

Winter Nominated Value = WPL x ZWWAF – WFSL (adjusted for loss factor)

- Winter Peak Load (WPL) = Average of customer's specific peak hourly load between HE7 through HE21 on the PJM defined 5 coincident peak winter days
- Zonal Winter Weather Adjustment Factor (ZWWAF) = Weather normalization factor
- Winter Firm Service Level (SFSL) = pre-defined level for which a customer's load can be reduced to when dispatched in the winter

Example:
WPL = 12 MW
ZWWAF = 1.0
WFSL = 0
Winter Nominated Value = 12 MW

Annual ICAP of Demand Resources = lesser of Summer and Winter Nominated Values

Background: Simulated DR Availability in ELCC Model

- Demand Resources have performance windows that differ by season

Summer	Winter
10:00AM to 10:00PM EPT	6:00AM to 9:00PM EPT

- In the ELCC analysis, DR availability during hours within the performance window is modeled to be scaled proportional to system load

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

- DR availability during hours outside of the performance window is assumed to be zero

Review: DR Analysis and Observations: Winter Peak Load (WPL)

- Winter Peak Load (WPL) values are used to determine the winter nominated value of DR customers and registrations
- The current WPL calculation uses the average of each customer's specific maximum hourly load between HE7 through HE21 on the five PJM defined winter coincident peak days (5WCP), with limited exception

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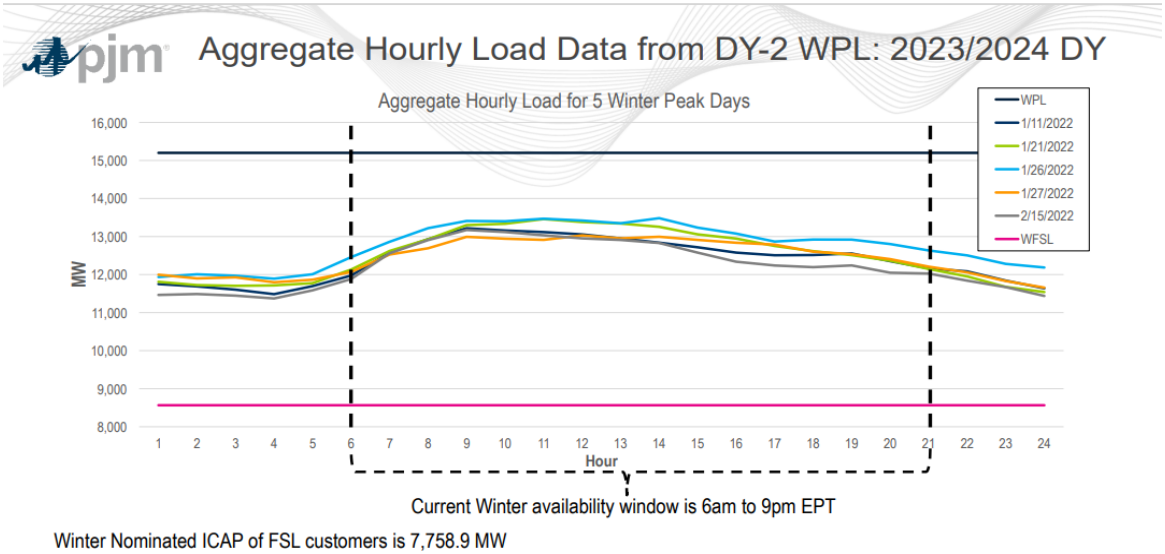
- When this formula is used for many individual customers, it results in a total WPL that overstates the expected load and corresponding reduction capability of the DR fleet in any one hour, as different customers experience their peak loads at different times of the day
  - *This issue is illustrated in the simple example at right*
  - *Observed in DR registration data for different DYs when comparing aggregate WPL to the total hourly loads of customers during the 5 winter peak days*

Example Customer Load (kW) during 5 winter peak days

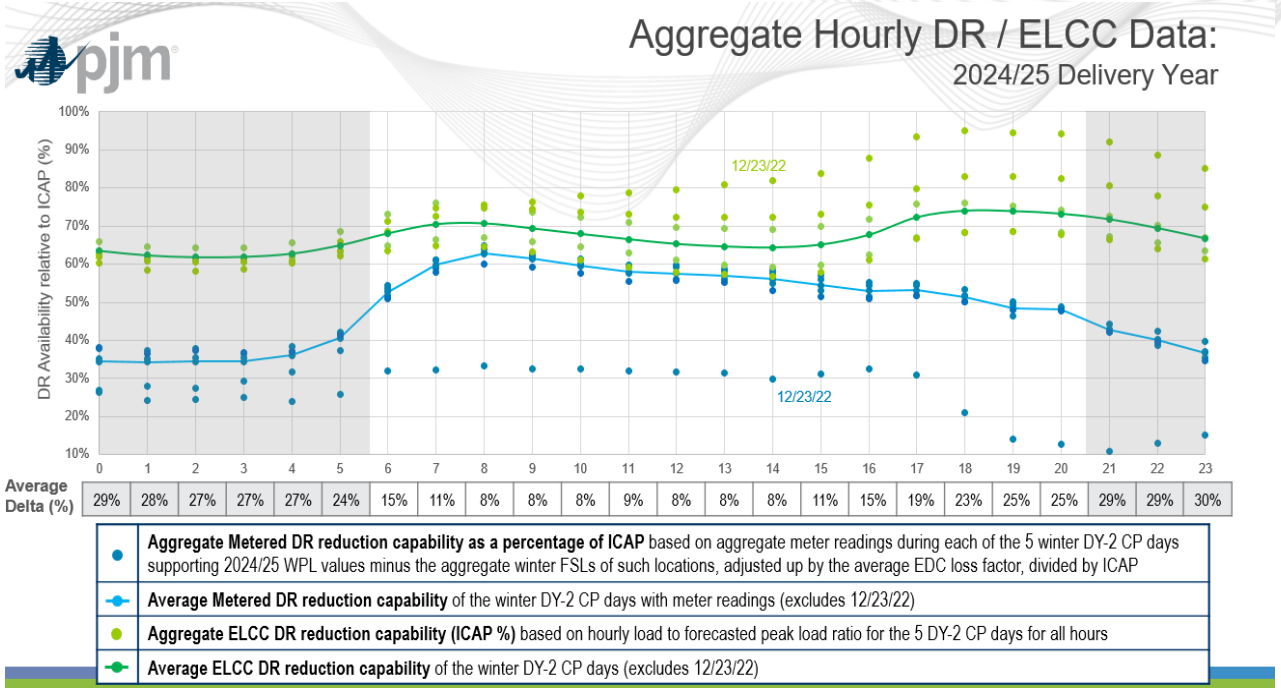
Customer	7AM	8AM	9AM	5PM	6PM	Max
A	500	600	500	500	500	600
B	500	700	1000	400	400	1000
C	500	500	500	1000	900	1000
Total	1500	1800	2000	1900	1800	**2600**

Total WPL = 2600 kW, while maximum total hourly load is 2000 kW



Winter Nominated ICAP of FSL customers is 7,758.9 MW

Review: DR Analysis and Observations: Winter ELCC Modeling vs. Historical Loads



Presented at the Aug. 7 MIC, the figure above compares the estimated reduction capability of DR based on the aggregate hourly metered loads of customers during the 5 winter peak days minus winter FSL (in blue) to the reduction capability used in the ELCC analysis during those same days (in green), as a percentage of winter ICAP for the 2024/25 DY

- The current ELCC heuristic (green line in figure) tends to overestimate the reduction capability of DR during winter hours within the performance window, and would further overestimate reduction value if extended for hours outside the current performance window
- There is a fairly significant amount of load above the WFSL from DR customers today in hours outside the current performance window, such that expanding the window to include those hours could provide substantially more reduction capability and reliability value from DR that is not captured today
- The aggregate hourly load shape of DR customers in the winter tends to have a different shape than the system load (slow decline after the morning peak with no second peak)

Review: PJM Solution Options

Design Component	Status Quo	Solution Option
DR Availability Window	**Summer:** 10AM-10PM EPT **Winter:** 6AM-9PM EPT	Extend the current DR performance window to 24 hours and reflect expected reduction capability in all hours in ELCC analysis and other RA studies. **Key Benefits** • Captures the load and curtailment capability of existing DR customers in the risk analysis and accreditation during hours of reliability risk outside the current window • Improves incentives to have CSPs sign up customers that are capable of responding during any hour of reliability risk and sets performance expectations for existing / new DR customers to respond at such times • Improves parity with generation resources that have 24x7 performance obligations *Note: This solution option would only be considered in conjunction with other reforms to improve modeling of DR capability in extended winter hours.*

Review: PJM Solution Options (cont'd)

Design Component	Status Quo	Solution Option
DR ICAP: **Winter Nominated Value**	Winter Nominated Value = (WPL * ZWWAF – WFSL) * Loss Factor WPL (Winter Peak Load) based on each customer's peak usage between HE7 through HE21 during 5WCP days ZWWAF (Zonal Winter Weather Adjustment Factor) WFSL (Winter Firm Service Level)	Modify the WPL calculation to be based on the customer's load during a consistent peak hour across the 5WCP days to address overstated WPL issue. Initially recommending an hour during the morning peak of the winter (i.e. HE9) where we see the highest aggregate load levels of DR customers, most of the winter loss-of-load risk, and most of the recent historical winter coincident peak hours. Reconsidering if the use of a weather normalization factor is appropriate for the DR load and Winter Nominated Value calculation. *Note: CSPs will still be required to provide PJM 24 hour metered load data during the 5WCP days to inform ELCC load profiles and reduction capability of DR customers in the winter.*

Review: PJM Solution Options (cont'd)

Design Component	Status Quo	Solution Option
ELCC Analysis: **Modeling of Hourly DR Availability and Reduction Capability**	Hourly DR availability and reduction capability scaled up and down proportional to system load $\frac{Simulated\ HourlyLoad_i}{50/50\ Simulated\ Peak\ Load\ Forecast} \times ICAP\ of\ DR$	**Winter:** Determine a forecasted level of DR Winter Nominated Value to use in the ELCC analysis. Shape the hourly DR load and reduction capability in the ELCC analysis based on the aggregate hourly load profiles provided in support of WPL values from recent registrations to address the differences observed between system load shape and DR loads. **Summer:** Status quo (risk concentrated in peak hours during summer; looking to collect additional information in DR registrations in future on summer hourly load profiles during summer peak days)

Winter Example: Forecasted Winter Nominated DR = **8,000 MW**, assuming WPL = 8,000 MW and WFSL = 0 for simplicity

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Aggregate average hourly DR load profile (relative to WPL in HE9) during PJM defined 5 winter coincident peak days:																							
0.65	0.63	0.63	0.63	0.65	0.72	0.85	0.93	1.0	0.98	0.97	0.95	0.95	0.93	0.92	0.88	0.85	0.85	0.83	0.8	0.77	0.73	0.68	0.65
Aggregate hourly DR reduction capability in winter:																							
5200	5040	5040	5040	5200	5760	6800	7440	8000	7840	7760	7600	7600	7440	7360	7040	6800	6800	6640	6400	6160	5840	5440	5200

ELCC Sensitivities under Proposed DR Reforms

ELCC Runs	Status quo	Sensitivity 1	Sensitivity 2
ELCC DR Modeling (26/27 BRA)	• DR ICAP = 7954 MW • DR reduction capability scaled proportional to system load within performance window • DR reduction set to zero outside window	• DR ICAP = 5705 MW • WPL and winter hourly profile / reduction capability based on 24/25 registration data • Assumes no change to nominated winter FSL • 24/7 performance window	• DR ICAP = 7954 MW • Similar to Sensitivity 1, except winter FSL reduced and Winter Nominated Value scaled up to equal original forecasted DR ICAP
FPR	**0.9367**	**0.9573**	**0.9577**
DR ELCC Rating	**74%**	**92%**	**94%**

ELCC Sensitivities with Proposed DR Reforms (cont'd)

ELCC Runs	EUE	LOLH	LOLE
Status quo	W:87% S:13%	W:71% S:29%	W:55% S:45%
Sensitivity 2 *(near identical results observed in Sensitivity 1)*	W:83% S:17%	W:66% S:34%	W:51% S:49%

- Majority of ratings remain unchanged or move +/- 1% or +/- 2%, largely driven by decrease in winter share of loss of load risk
- After DR, storage classes see largest increase in rating, largely driven by relatively shorter loss of load events observed in the winter compared to status quo

Class	Status Quo	Sensitivity 2	Delta
Onshore Wind	34%	32%	-2%
Offshore Wind	61%	57%	-4%
Solar Fixed	8%	9%	1%
Solar Tracking	13%	14%	1%
Landfill Gas Intermittent	54%	55%	1%
Hydro Intermittent	38%	38%	0%
4-hr Storage	57%	67%	10%
6-hr Storage	65%	76%	11%
8-hr Storage	68%	77%	9%
10-hr Storage	78%	86%	8%
DR	74%	94%	20%
Nuclear	95%	95%	0%
Coal	84%	84%	0%
Gas CC	78%	79%	1%
Gas CT	68%	70%	2%
Gas CT Dual	79%	80%	1%
Diesel Utility	91%	91%	0%
Steam	74%	75%	1%

Added Solution Option:
DR Compliance Calculations

DR Compliance Calculations: Status Quo

- DR compliance calculations for PAIs and testing currently focus on seasonal peak load values to determine the level of reduction achieved and if that reduction amount meets the committed level

  Capacity Load Reduction MW = Seasonal Peak Load – Metered Load *(adjusted for losses)*

- When DR is dispatched within their performance window during a PAI, Load Reduction MW is compared to committed ICAP to determine if short or eligible for bonus (on an aggregate basis by CSP)

- When DR is dispatched outside the performance window during a PAI, compliance is voluntary and any Load Reduction MW is eligible for bonus

  (Note: This would no longer be applicable under the proposed solution option that extends the performance window to be 24/7)

Simple DR Example						
Peak Load	FSL	ICAP	ELCC (%)	UCAP	Committed ICAP	Committed UCAP
100	0	100	90%	90	100	90

DR Performance during PAIs	Hour 1 (peak)	Hour 2 (11pm)
DR Hourly Load Profile	100	80
Peak Load	100	100
Metered Load	0	0
Capacity Load Reduction MW (Actual Performance)	100	100
Committed ICAP (Expected Perf)	100	-
PAI Compliance MW	+0	+100

DR Compliance Calculations: Observations

- With risk hours and reliance on DR extending beyond just the peak hour in each season, both today and even more so under a 24/7 performance window, the current compliance calculation that focuses on metered load levels relative to seasonal peak loads can overstate the level of reduction value provided in certain instances, particularly in cases where the Demand Resource is not fully committed
- This can be observed in the following example that assumes DR behavior and risk in the Delivery Year exactly match expectations in the ELCC analysis under a 24/7 performance window, yet DR earns more Bonus MW than their Accredited UCAP or average reduction value provided during risk hours

Illustrative DR Example

Peak Load	FSL	ICAP	ELCC (%)	UCAP	Committed ICAP	Committed UCAP
100	0	100	90%	90	0	0

ELCC Analysis: Assumes 100 DR ICAP and 2 hours with loss of load risk in model	**Hour 1 (peak)**	**Hour 2 (11pm)**
DR Hourly Load Profile in ELCC Analysis	100	80
FSL	0	0
Reduction Amount	100	80
Hourly Risk Weighting (%)	50%	50%
Risk-Weighted Avg. Reduction (i.e. UCAP)		90 MW

DR Performance during PAIs	**Hour 1**	**Hour 2**
DR Hourly Load Profile	100	80
Peak Load	100	100
Metered Load	0	0
Reduction MW (*PeakLoad - Metered Load*)	100	100
Committed ICAP	0	0
PAI Compliance MW	+100	+100
Status Quo Average Hourly Compliance MW		+100

DR Compliance Calculations: PJM Solution Option

Design Component	Status Quo	Solution Option
DR Compliance Calculation for PAIs and Testing	**Summer:** Load Reduction MW = PLC – Metered Load *(adjusted for loss factors)* **Winter:** Load Reduction MW = WPL * ZWWAF – Metered Load *(adjusted for loss factors)* **DR Compliance MW** = Load Reduction MW – Committed MW	Modify the current compliance calculation to determine bonus or shortfall MW based on if metered load is reduced to above or below the seasonal FSL for which the Demand Resource has committed to reduce to. **DR Compliance MW = Seasonal FSL – Metered Load** *(adjusted for loss factors)* For fully committed Demand Resources, aggregate metered load is compared to the aggregate seasonal FSL of registrations linked to the Demand Resource. For partially committed Demand Resources, compliance is calculated similarly, except seasonal FSL is adjusted up by the uncommitted UCAP on the Demand Resource. **Key Benefits** • More accurately assesses the load reduction value provided by DR during events in certain scenarios, particularly when not fully committed. • Provides a load reduction measure that's more consistent with the ELCC analysis and the FSL design in which DR is committing to reduce to a certain level.

DR Compliance Calculations:
Solution Option - Example 1

Scenario: The following scenarios continue the earlier 100 MW simplified example where DR behavior and risk hours during the year match expectations in the ELCC analysis, and shows how compliance is determined under the proposed solution vs. status quo under varying commitment and reduction levels. **This scenario assume 100% commitment and load reduction**.

Peak Load	FSL	ICAP	ELCC	UCAP	Committed ICAP	Committed UCAP
100	0	100	90%	90 MW	100 MW	90 MW

ELCC Analysis: Assumes 100 DR ICAP and 2 hours with loss of load risk in model	**Hour 1 (peak)**	**Hour 2 (11pm)**
DR Hourly Load Profile in ELCC Analysis	100	80
FSL	0	0
Reduction Amount	100	80
Hourly Risk Weighting (%)	50%	50%
Risk-Weighted Avg. Reduction (i.e. UCAP)		90 MW

DR Performance during PAIs	**Hour 1**	**Hour 2**
DR Hourly Load Profile	100	80
Peak Load	100	100
Metered Load	0	0
Status Quo Reduction MW *(Peak Load – Metered Load)*	100	100
Committed ICAP	100	100
Status Quo Compliance MW	+0	+0
Status Quo Average Hourly Compliance MW		**+0**

FSL	0	0
Proposed Compliance MW *(FSL – Metered Load)*	+0	+0
Proposed Average Hourly Compliance MW		**+0**

Key Takeaway: PAI compensation is net zero when fully committed DR performs exactly as expected during risk hours. Results are the same under proposed compliance calculation and status quo.

DR Compliance Calculations: Solution Option - Example 2

Scenario: Same as Example 1 except the Demand Resource **provides zero reduction value and underperforms during PAIs** in this example.

Peak Load	FSL	ICAP	ELCC	UCAP	Committed ICAP	Committed UCAP
100	0	100	90%	90 MW	100 MW	90 MW

ELCC Analysis: Assumes 100 DR ICAP and 2 hours with loss of load risk in model	**Hour 1 (peak)**	**Hour 2 (11pm)**
DR Hourly Load Profile in ELCC Analysis	100	80
FSL	0	0
Reduction Amount	100	80
Hourly Risk Weighting (%)	50%	50%
Risk-Weighted Avg. Reduction (i.e. UCAP)		90 MW

DR Performance during PAIs	**Hour 1**	**Hour 2**
DR Hourly Load Profile	100	80
Peak Load	100	100
Metered Load	100	80
Status Quo Reduction MW *(Peak Load – Metered Load)*	0	20
Committed ICAP	100	100
Status Quo Compliance MW	-100	-80
Status Quo Average Hourly Compliance MW		**-90**

FSL	0	0
Proposed Compliance MW *(FSL – Metered Load)*	-100	-80
Proposed Average Hourly Compliance MW		**-90**

Key Takeaway: PAI shortfall consistent with the zero reduction value provided by the DR where average underperformance equals the full committed UCAP. Same results under proposed option and status quo.

DR Compliance Calculations: Solution Option - Example 3

Scenario: Same as Example 1 except the Demand Resource **has zero capacity commitment, but fully reduces to FSL** for bonus compensation in this example.

Peak Load	FSL	ICAP	ELCC	UCAP	Committed ICAP	Committed UCAP
100	0	100	90%	90 MW	0 MW	0 MW

ELCC Analysis: Assumes 100 DR ICAP and 2 hours with loss of load risk in model	**Hour 1 (peak)**	**Hour 2 (11pm)**
DR Hourly Load Profile in ELCC Analysis	100	80
FSL	0	0
Reduction Amount	100	80
Hourly Risk Weighting (%)	50%	50%
Risk-Weighted Avg. Reduction (i.e. UCAP)		90 MW

DR Performance during PAIs	**Hour 1**	**Hour 2**
DR Hourly Load Profile	100	80
Peak Load	100	100
Metered Load	0	0
Status Quo Reduction MW *(Peak Load – Metered Load)*	100	100
Committed ICAP	0	0
Status Quo Compliance MW	+100	+100
Status Quo Average Hourly Compliance MW		**+100**

FSL *(adjusted up by uncommitted UCAP)*	90	90
Proposed Compliance MW *(FSL – Metered Load)*	+90	+90
Proposed Average Hourly Compliance MW		**+90**

Key Takeaway: Under the proposed solution, PAI bonus matches the average reduction in load provided during PAIs relative to the risk-weighted load levels in ELCC analysis under proposed solution option

DR Compliance Calculations:
Solution Option - Example 4

Scenario: Same as Example 1 except the Demand Resource **has a partial capacity commitment and fully reduces to FSL during PAIs** for bonus compensation in this example.

Peak Load	FSL	ICAP	ELCC	UCAP	Committed ICAP	Committed UCAP
100	0	100	90%	90 MW	90 MW	81 MW

ELCC Analysis: Assumes 100 DR ICAP and 2 hours with loss of load risk in model	**Hour 1 (peak)**	**Hour 2 (11pm)**
DR Hourly Load Profile in ELCC Analysis	100	80
FSL	0	0
Reduction Amount	100	80
Hourly Risk Weighting (%)	50%	50%
Risk-Weighted Avg. Reduction (i.e. UCAP)		90 MW

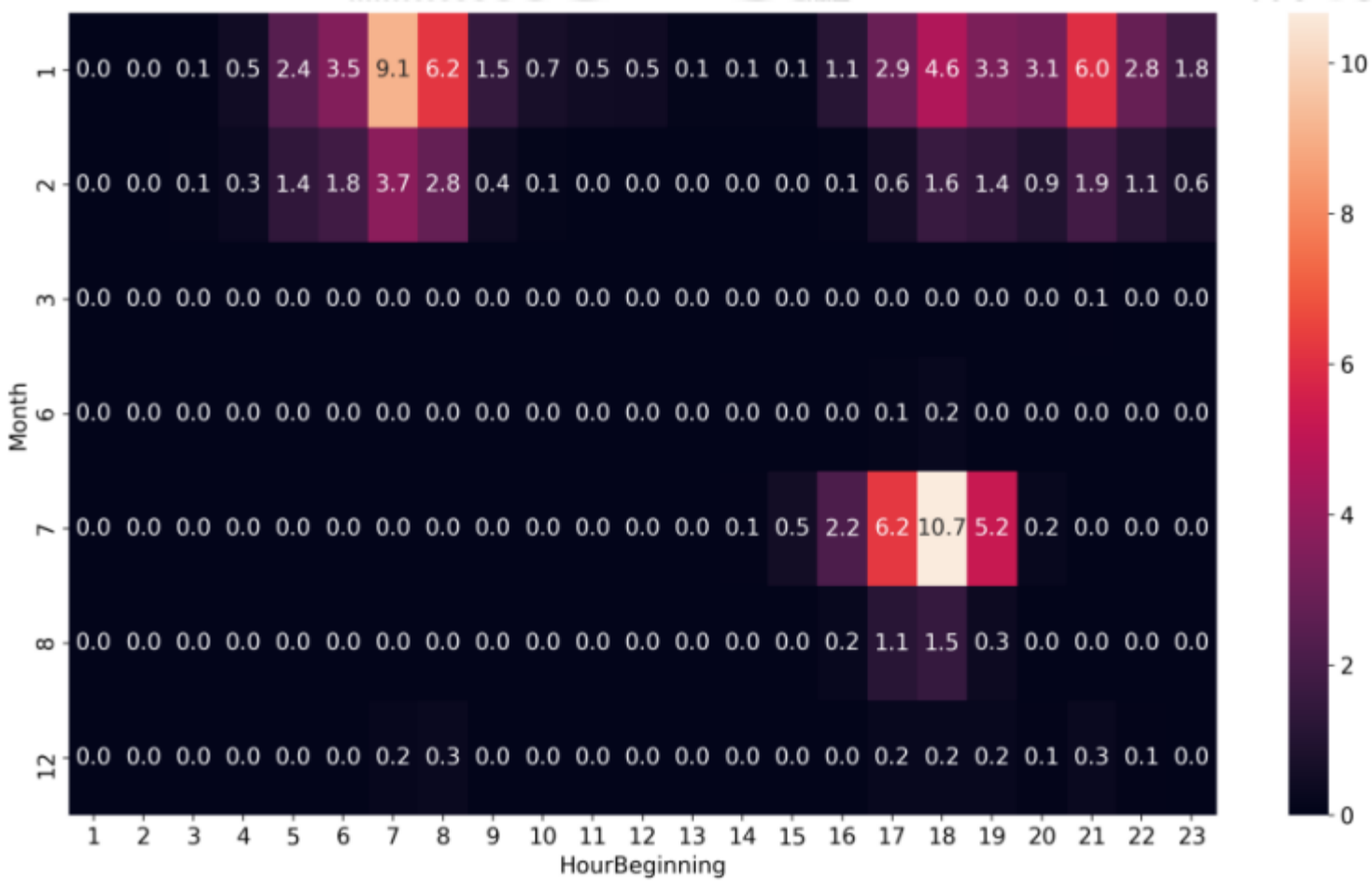
DR Performance during PAIs	**Hour 1**	**Hour 2**
DR Hourly Load Profile	100	80
Peak Load	100	100
Metered Load	0	0
Status Quo Reduction MW *(Peak Load – Metered Load)*	100	100
Committed ICAP	90	90
Status Quo Compliance MW	+10	+10
Status Quo Average Hourly Compliance MW		**+10**

FSL *(adjusted up by uncommitted UCAP)*	9	9
Proposed Compliance MW *(FSL – Metered Load)*	+9	+9
Proposed Average Hourly Compliance MW		**+9**

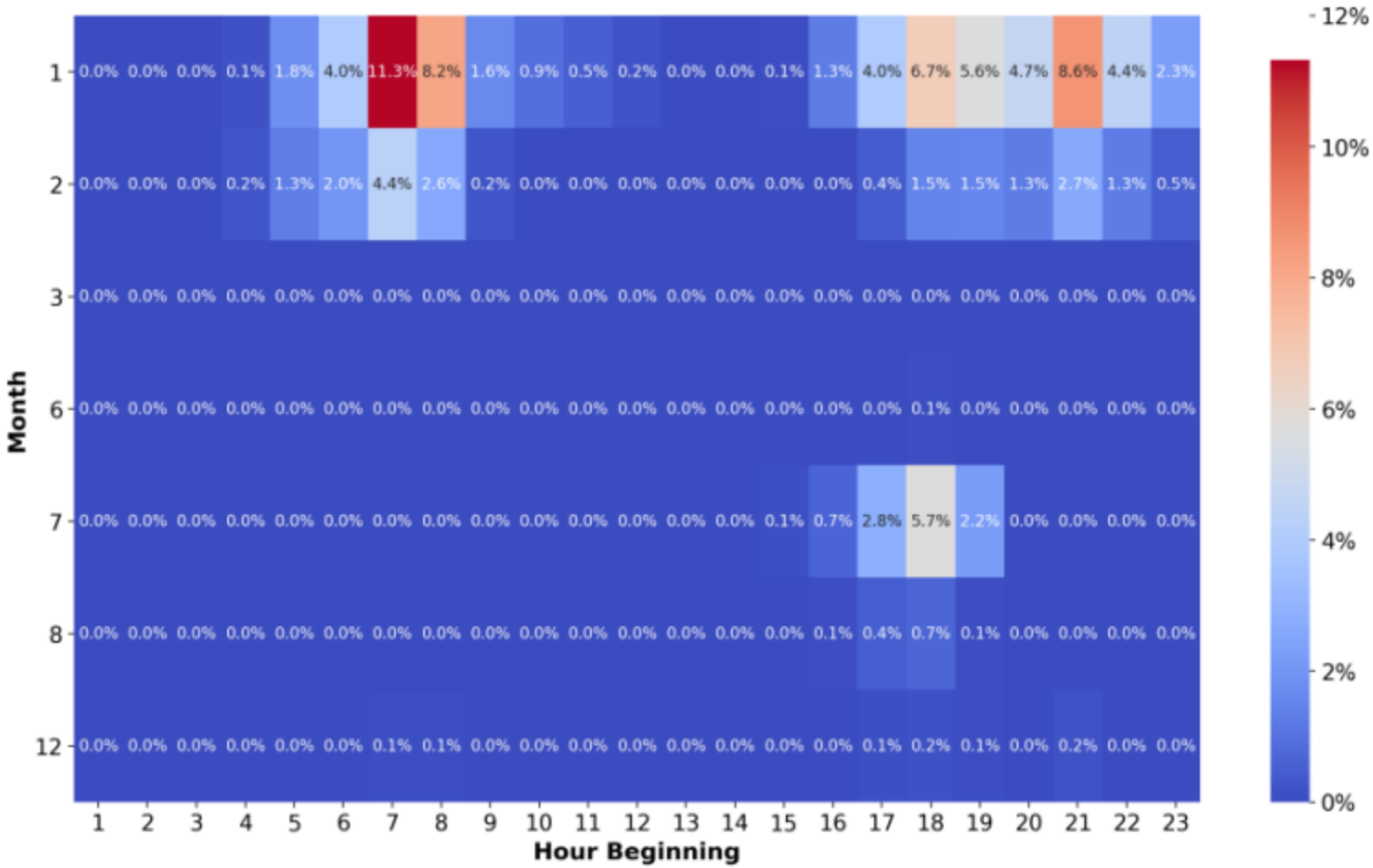
Key Takeaway: Under proposed solution, level of PAI bonus is consistent with reduction value provided beyond the committed amount (performed at 100% UCAP with avg. reduction of 90 MW, 9 MW above committed UCAP level)

Appendix: Reference Materials

26/27 BRA LOLH Month/Hour Heatmap



26/27 BRA EUE Month/Hour Heatmap



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