PacifiCorp 2013 Stress Factor Analysis Docket No. 11-035-200
Part 6
Loss of Load Probability Study

PacifiCorp completed a loss of load probability study (LOLP Study) in support of its 2013 Integrated Resource Plan (IRP).[1] The LOLP Study measures how system costs and reliability metrics are affected at different planning reserve margin levels.[2] The purpose of the LOLP Study is to establish a planning reserve margin that can be applied in the IRP portfolio development process. Modeling for the LOLP Study differs from standard IRP stochastic risk analysis primarily by assuming self-reliance when meeting load.

The LOLP modeling framework includes three discrete steps. Two of these steps are similar to the modeling framework used in the IRP process. This includes a step using the System Optimizer model to develop resource portfolios for a range of planning reserve margin levels and a step using the Planning and Risk model (PaR) to evaluate the cost of those portfolios.[3] The remaining step, which is unique to the LOLP modeling framework, uses PaR to generate and report specific reliability metrics that are not produced in the standard stochastic risk analysis performed as part of the IRP. This is referred to as the Reliability Model in PacifiCorp's 2013 LOLP Study. The following table summarizes key differences in the configuration of the Reliability Model and the standard stochastic risk analysis used to evaluate resource portfolio costs in the IRP.

Attribute	LOLP Study Reliability Model	IRP Stochastic Risk Analysis
System Balancing (Hourly) Market Transactions	Not Allowed	Allowed
Stochastic Variables	Outages, Load	Outages, Load, Market Prices
Proxy Resource Station	Yes	No
Monte-Carlo Draws	500	100
Study Period	1-year	20-years
Sample Weeks	12-weeks per year	6-weeks per year
Time Step	1-hour	4-hours

The Reliability Model is configured to measure the ability of the system to maintain reliability without being able to rely on short-term system balancing market purchases. Because the Reliability Model is not used to evaluate portfolio costs, market prices are not modeled as stochastic variables. As Monte Carlo draws are made for both load and outages across 500 iterations, proxy resource stations are configured to

[1] The LOLP Study was performed by Ventyx and is included in Volume II, Appendix I of PacifiCorp's 2013 IRP.
[2] The planning reserve margin, expressed as a percentage of the coincident system peak obligation (firm load net of interruptible loads and demand side management), ensures there is adequate system resources when accounting for short-term and long-term uncertainty in both loads and resources. The 2013 LOLP Study includes resource portfolios assuming planning reserve margins of 10%, increasing in increments of 1% up to 20%.
[3] PaR is a stochastic Monte Carlo production cost dispatch model. Stochastic variables used to evaluate portfolio costs in PaR include wholesale power prices, natural gas prices, unit availability, and load.

operate once the output from actual resources is fully exhausted.[4] The simulated operation of these proxy resource stations provide the data required to measure system reliability.[5] To ensure the reliability metrics generated by the Reliability Model adequately capture adverse outcomes, the model is configured with more temporal granularity as compared to the stochastic risk analysis used to evaluate portfolio costs in the IRP. For instance, the Reliability Model is configured with a one hour time step and simulates 12 sample weeks per year (one week for each calendar month) whereas the IRP stochastic risk analysis is configured with a 4-hour time step and simulates 6 sample weeks per year (one week for two contiguous calendar months).[6]

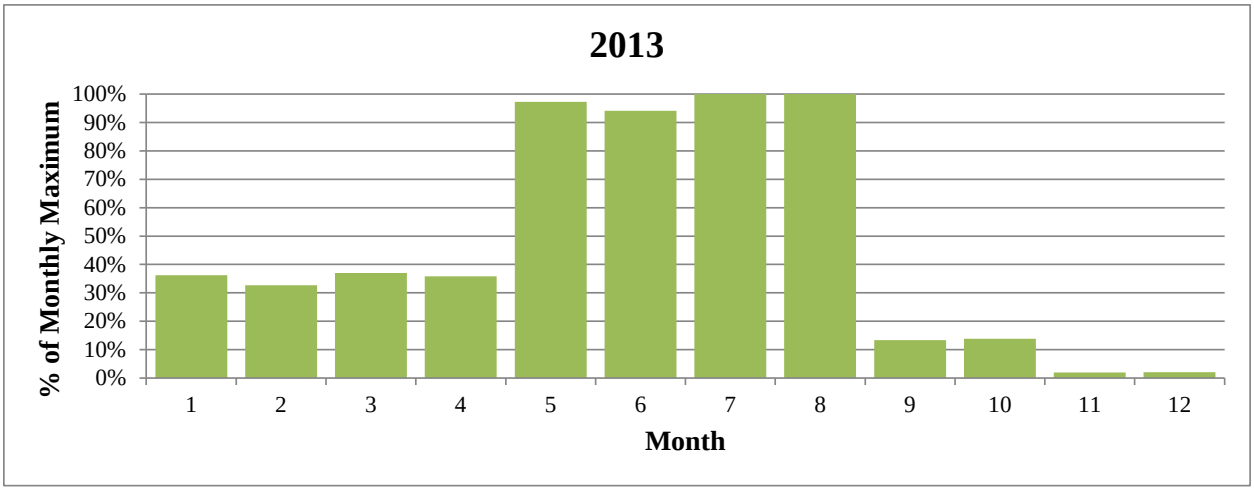
In summary, the LOLP Study provides a measure of system reliability using a Reliability Model, which differs from the standard IRP stochastic risk analysis primarily by assuming self-reliance when meeting load (system balancing purchases cannot be used to meet adverse system conditions). The LOLP Study is used to establish a planning reserve margin that can be applied in the IRP portfolio development process. The Reliability Model is not replicated for any of the resource portfolios produced in the IRP modeling process, and consequently, specific LOLP metrics, whether episode-based or duration-based, are not available for the 2013 IRP preferred portfolio.

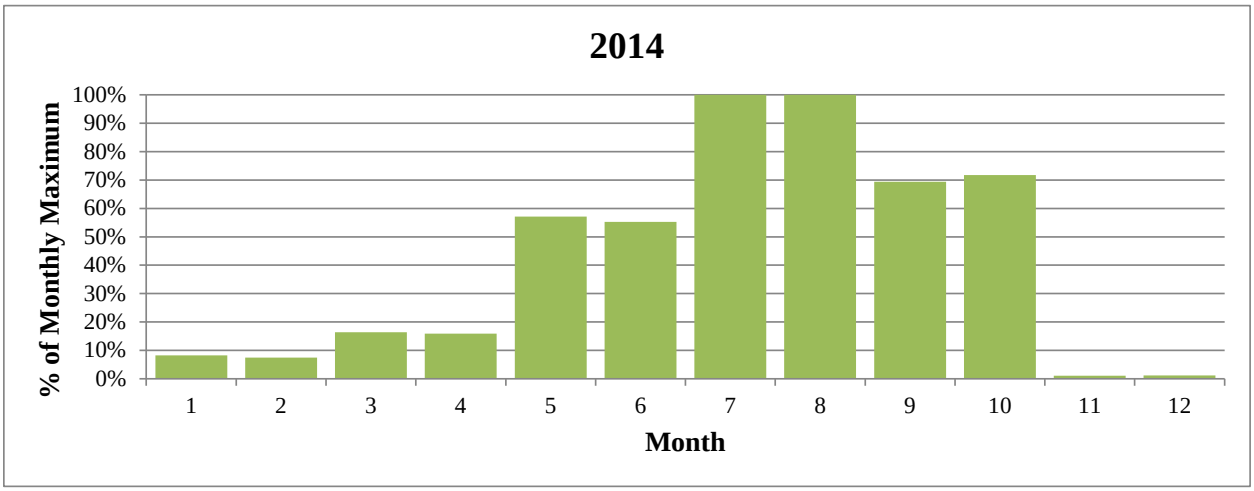
Preferred Portfolio Energy Not Served

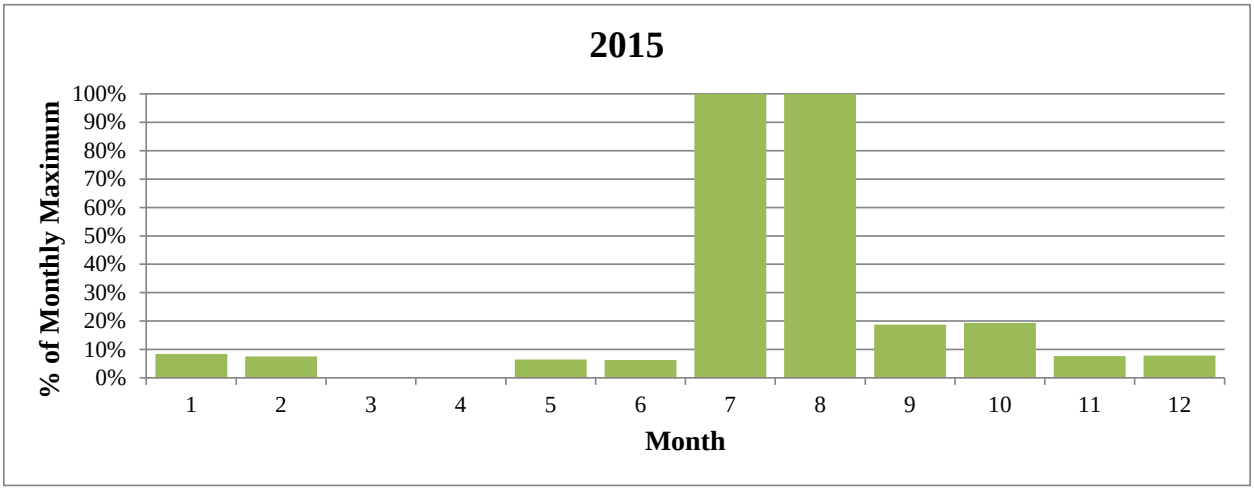
Based upon the 2013 LOLP Study, PacifiCorp adopted a 13% planning reserve margin in its 2013 IRP, and the 2013 IRP preferred portfolio reflects this planning reserve margin assumption. As noted above, the Reliability Model has not been applied to any resource portfolio evaluated in the IRP modeling process, and consequently, PacifiCorp does not have LOLP metrics that are specific to the preferred portfolio. Monthly energy not served (ENS) data, which represents the amount of load that cannot be met with either system resources or with system balancing market purchases, can be downloaded from the PaR model as configured to evaluate portfolio costs in the IRP. While ENS data from the IRP stochastic risk analysis provide a measure of reliability suitable for comparing ENS results among a range of different portfolios, these data are not directly comparable to the reliability metrics calculated in the LOLP Study primarily because the IRP simulations allow system balancing market purchases when evaluating portfolio costs. Attachment A summarizes monthly ENS data from the 2013 IRP Preferred Portfolio in which monthly ENS results are reported as a percentage of maximum monthly ENS for any given year. Attachment B contains the monthly ENS data in GWh by year.

[4] Convergence of expected unserved energy as measured by generation from the proxy resource was observed with 500 iterations. Convergence of system costs, as measured in IRP stochastic analysis, is observed with 100 iterations.
[5] Energy from the proxy resource stations provides a measure of energy not served. The number of starts from the proxy resource stations provides a count of reliability episodes. The number of hours when proxy resources produce energy provides a measure of how many hours system resources were not sufficient in meeting load.
[6] The number of iterations, the sample week configuration and the time step configuration used in the IRP stochastic risk analysis are limited by model performance for 20 year simulation periods. As noted above, with these settings, PacifiCorp has observed the convergence of system costs when using 100 iterations.

Attachment A
2013 IRP Preferred Portfolio Monthly ENS as Percentage of Maximum by Year






2015
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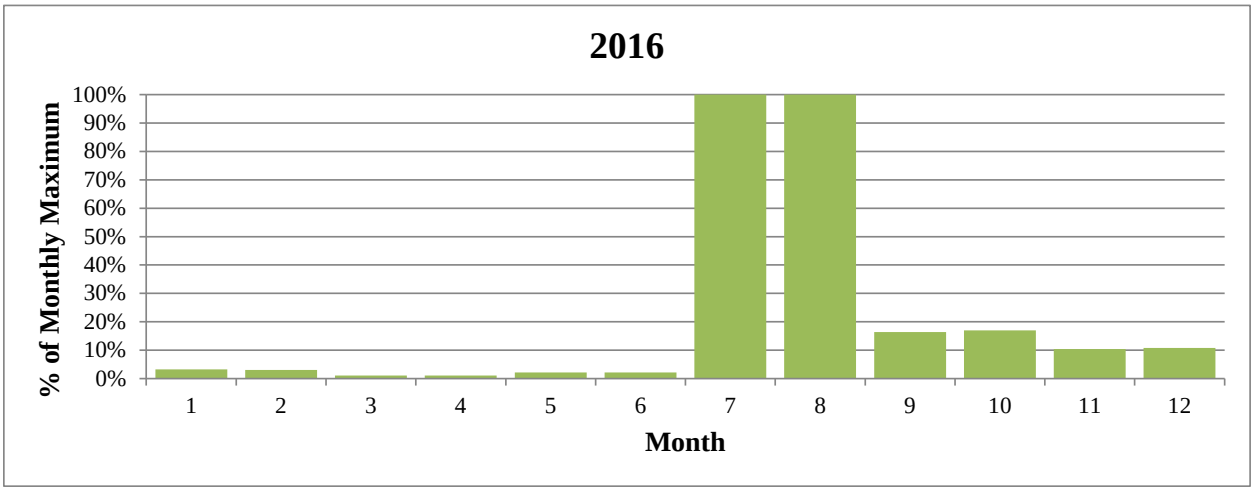
2016
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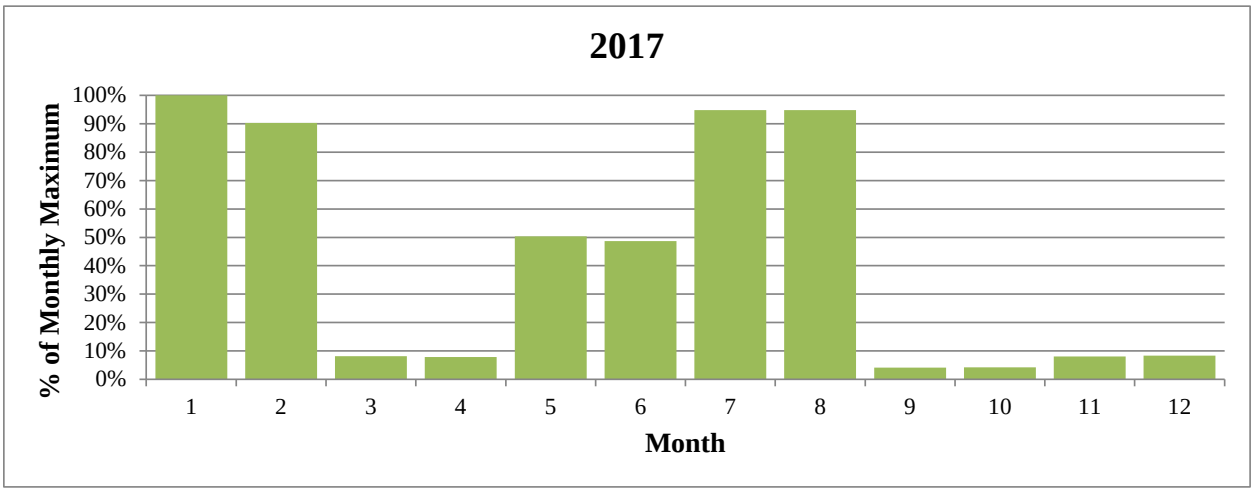
2017
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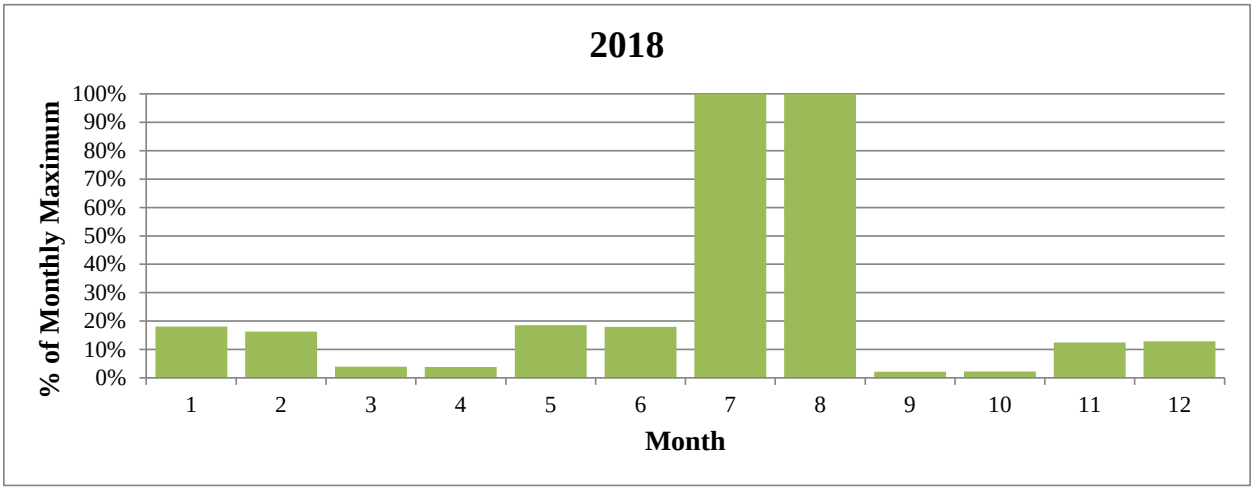
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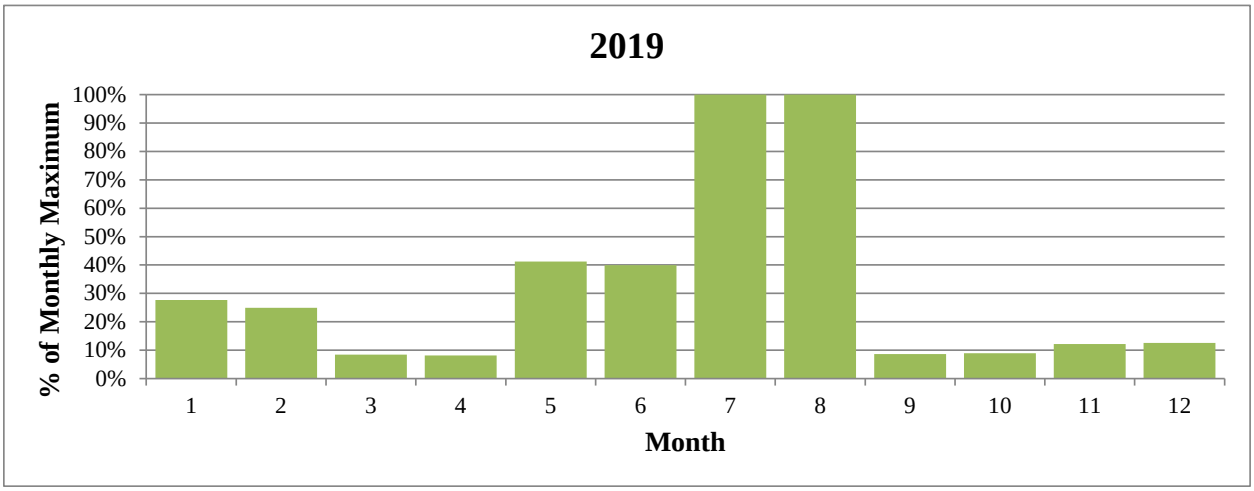
2019
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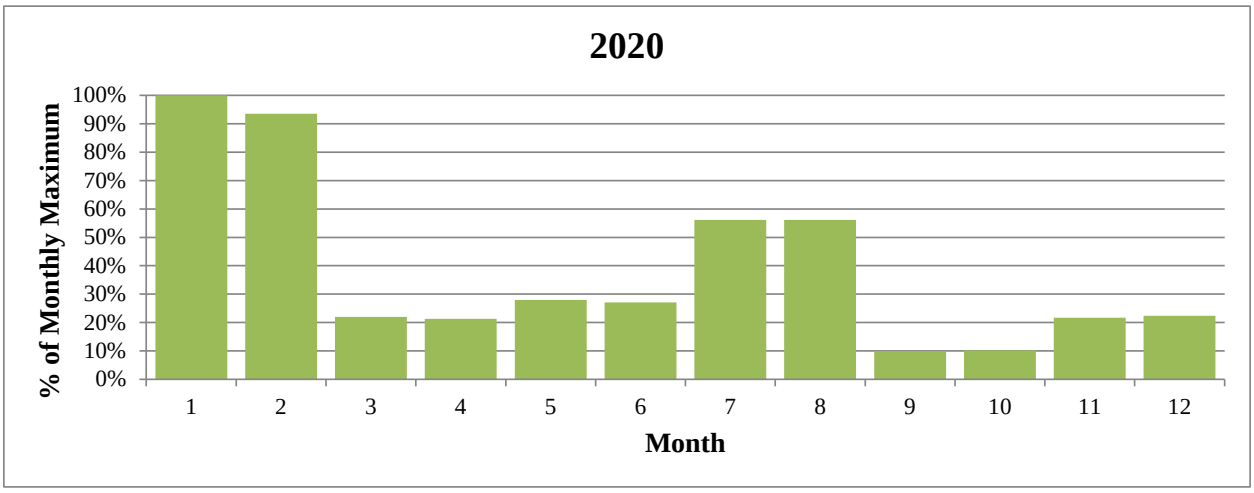
2020
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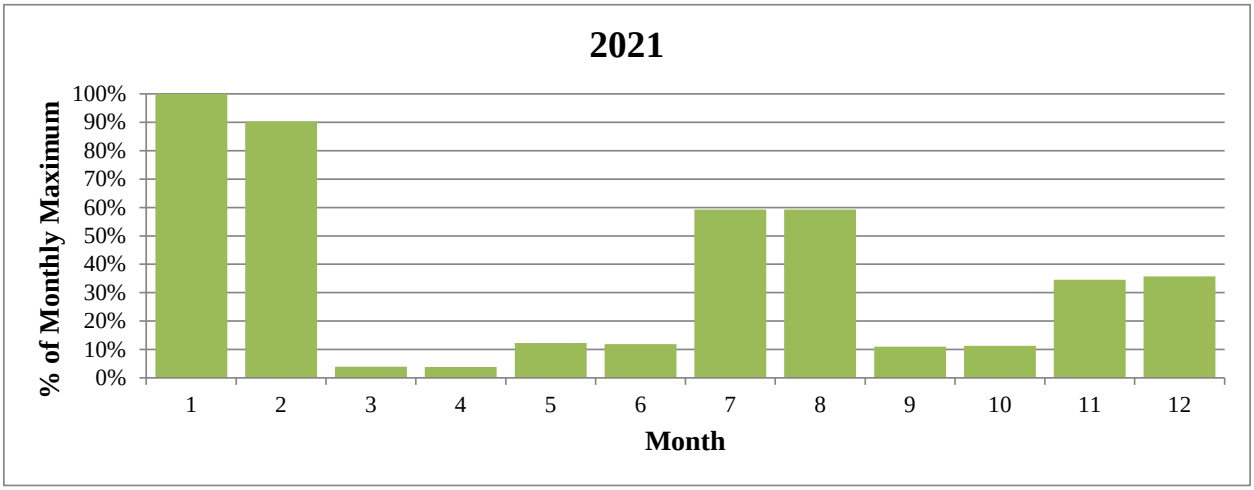
2021
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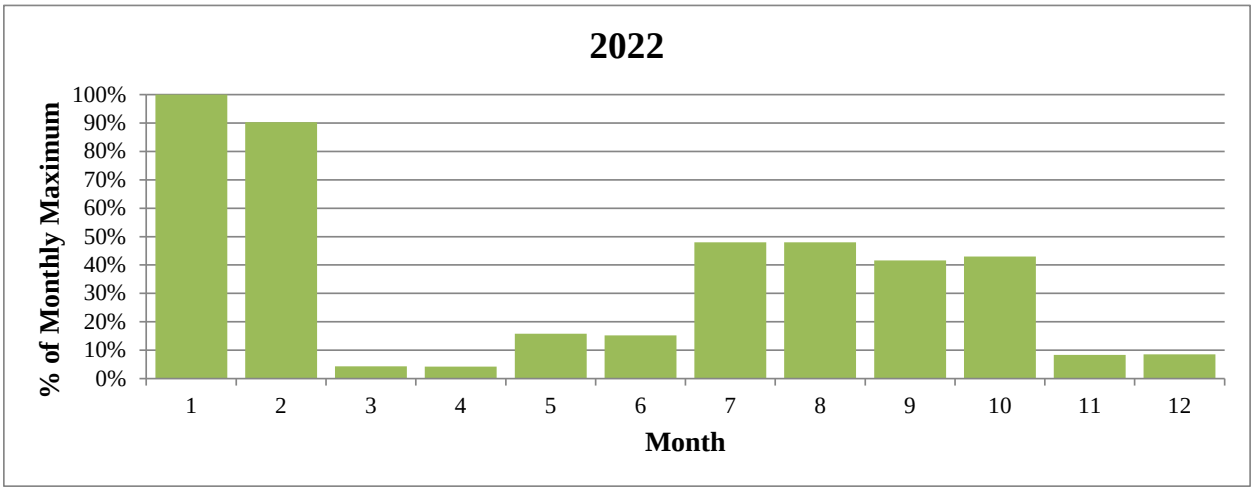
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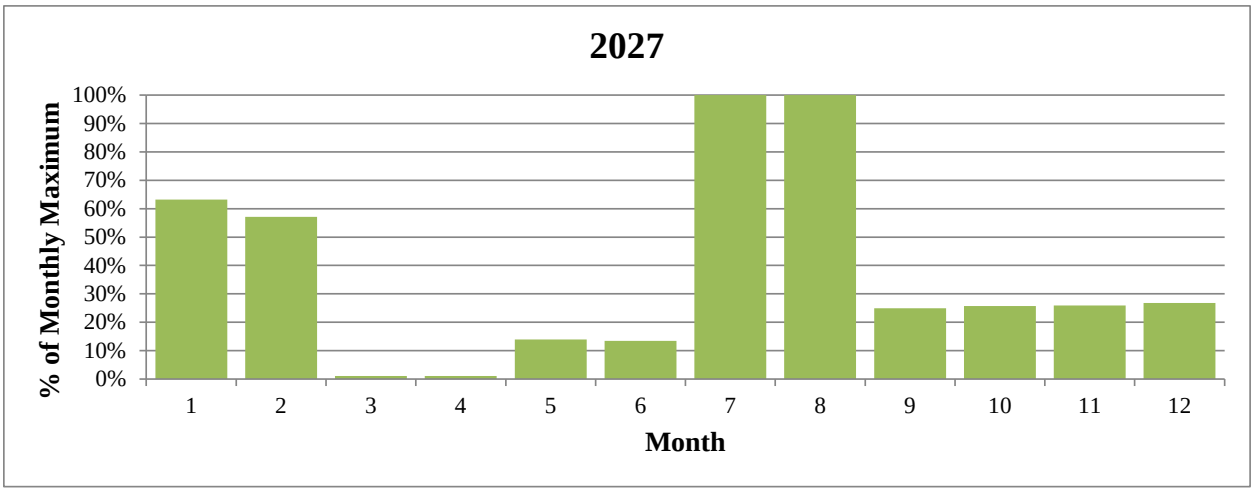
2027
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Attachment B
2013 IRP Preferred Portfolio Monthly ENS Data (GWh)

Month	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2027
1	0.920	0.220	0.220	0.120	8.580	3.690	4.590	11.320	10.680	23.220	8.050
2	0.831	0.199	0.199	0.112	7.750	3.333	4.146	10.590	9.646	20.973	7.271
3	0.940	0.440	0.000	0.040	0.700	0.810	1.400	2.490	0.420	1.010	0.140
4	0.910	0.426	0.000	0.039	0.677	0.784	1.355	2.410	0.406	0.977	0.135
5	2.470	1.530	0.170	0.080	4.320	3.790	6.850	3.170	1.310	3.660	1.770
6	2.390	1.481	0.165	0.077	4.181	3.668	6.629	3.068	1.268	3.542	1.713
7	2.540	2.680	2.620	3.650	8.130	20.420	16.600	6.360	6.330	11.150	12.740
8	2.540	2.680	2.620	3.650	8.130	20.420	16.600	6.360	6.330	11.150	12.740
9	0.340	1.860	0.490	0.600	0.350	0.450	1.430	1.120	1.170	9.660	3.170
10	0.351	1.922	0.506	0.620	0.362	0.465	1.478	1.157	1.209	9.982	3.276
11	0.050	0.030	0.200	0.380	0.690	2.550	2.020	2.450	3.690	1.930	3.300
12	0.052	0.031	0.207	0.393	0.713	2.635	2.087	2.532	3.813	1.994	3.410