Slice of Day Resource Counting – Exceedance

July 27, 2022 RA Reform Implementation Workshop (R. 21-10-002)

NP Energy on behalf of the Natural Resources Defense Council

NP ENERGY

Disclaimer: This presentation is offered for policy development and discussion purposes only. Formal positions offered by NRDC within the proceeding may evolve based on on-going discussions.

Key Takeaways

This presentation is intended to provide a refresher to stakeholders on key exceedance concepts and options for continued development and implementation.

- ***Exceedance Refresher:*** Multiple methods exist to calibrate resource profiles for Slice of Day. This presentation provides an overview of exceedance options.

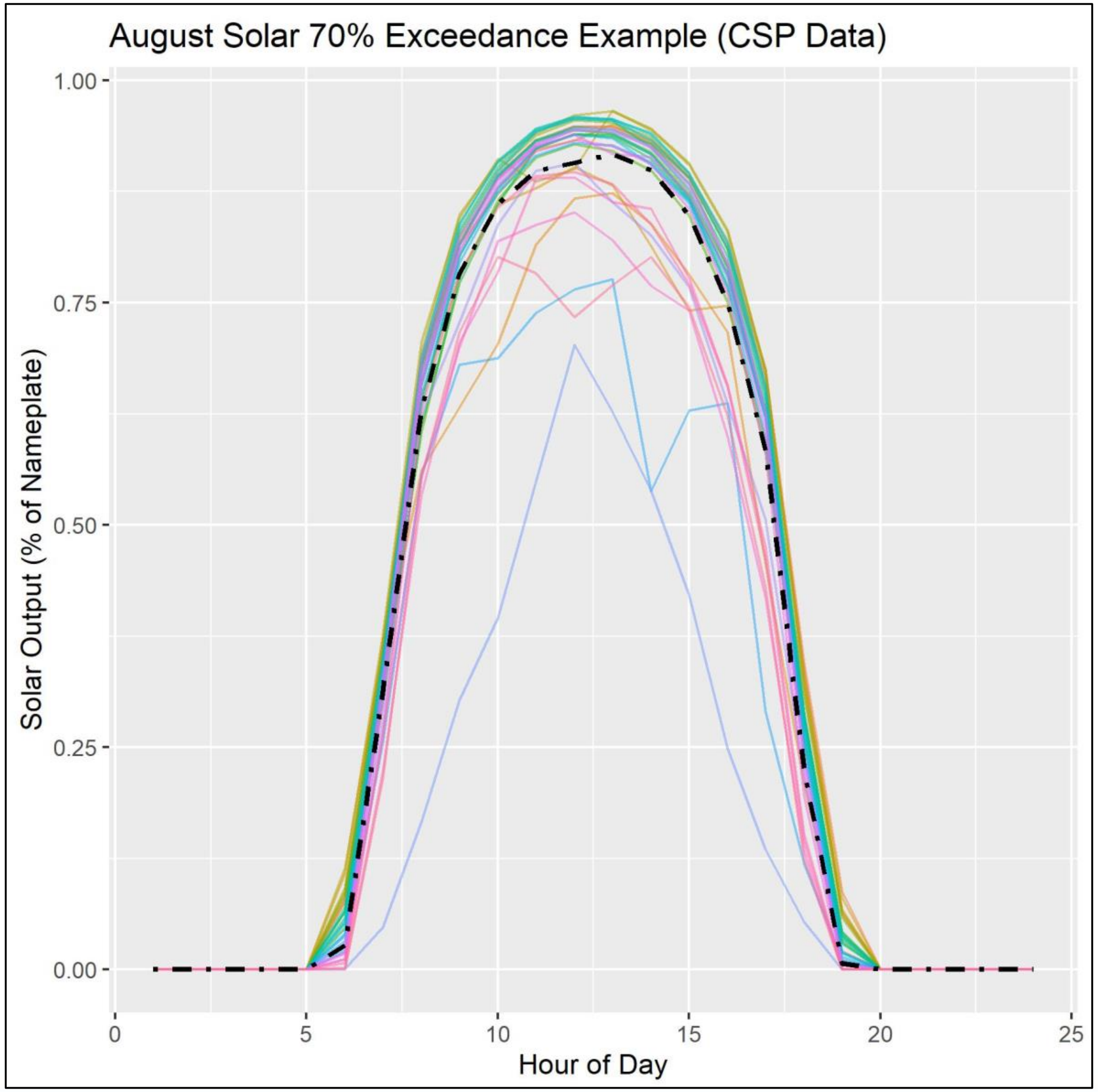
- ***Support for Peak Day and Use of LOLE Data:*** NRDC supports PG&E’s proposed Peak Day calibration approach (adopted by D.22-06-050, but encourages continued development of its Worst Day and LOLE-Informed proposals as alternatives.

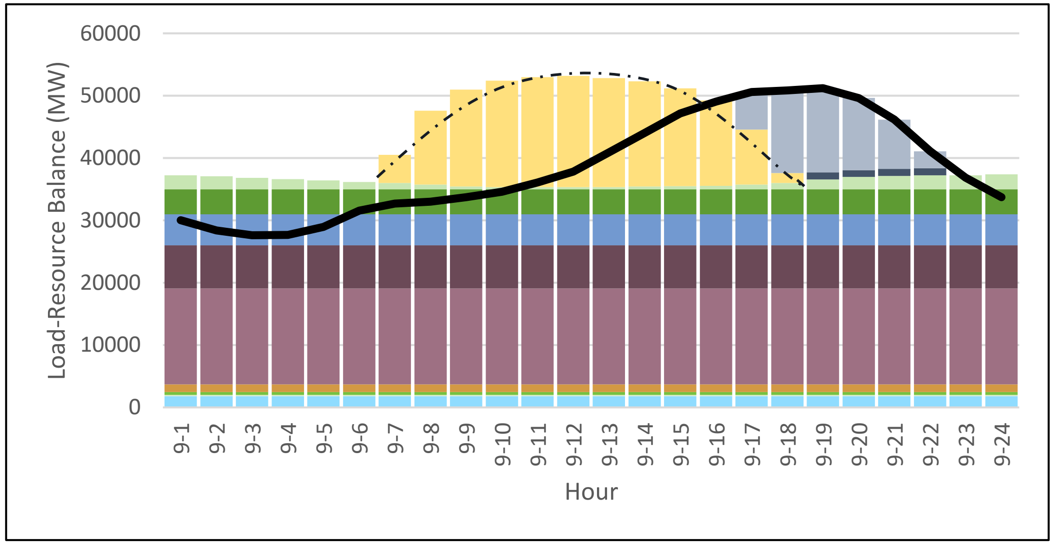
- ***Perfection is the Wrong Goal:*** Accuracy and precision in calibration are beneficial, but some error is inherent and is intended to be addressed in the PRM calibration process.

Note: This presentation uses resource profiles and demand from the 2022 Clean System Power tool to illustrate policy and methodology choices. NRDC recommends the use of historical data and/or robust, weather-aligned modeled data to calibrate resource profiles.

Refresher: What is Exceedance?

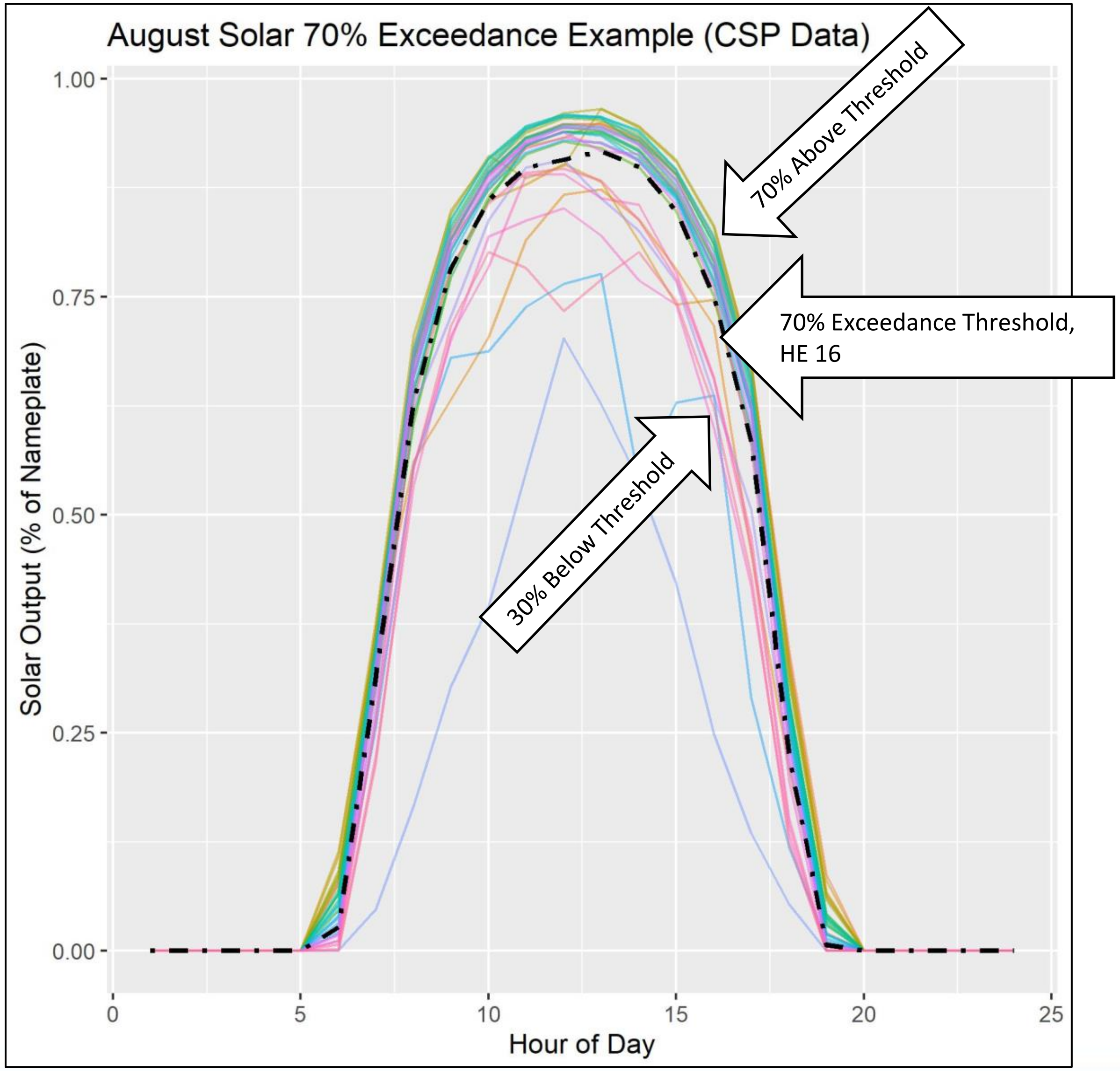
Refresher: Exceedance in Slice of Day





- Exceedance is the statistical method used to determine hourly resource values for variable renewable resources
- Exceedance determines the value that a resource is expected to produce at or above over a given percentage of observations:
- D.22-06-050 directed parties to further develop the exceedance methodology, specifically identifying PG&E's "Peak Day" exceedance methodology be used for calibration

Exceedance Basics



- ➢ Exceedance is determined on an hourly basis. For a given hour, the exceedance value is the threshold value above which N% of observations fall (in this example, 70%).

- ➢ Exceedance analysis can be performed on any data set:
  - ➢ Historical or modeled datasets may be used
  - ➢ Larger datasets will produce more robust results, but marginal value declines after 2-3 years of data
  - ➢ Modeled data must be built from reliable weather data which reflects real-world weather distributions

- ➢ Exceedance does not inherently consider correlation effects between resource performance and outage risk. Calibration efforts are intended to align exceedance with reasonably expected output during grid stress conditions.

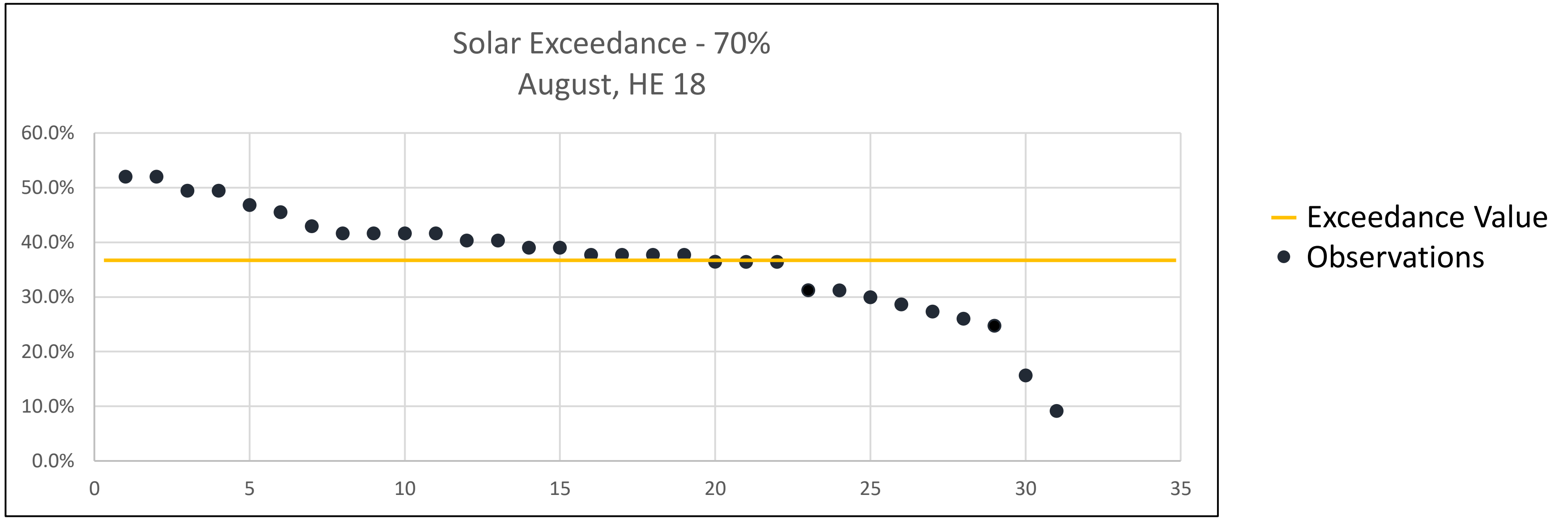
Exceedance Example: August, Hour 18

Solar Observations: August, Hour 18 (2022 CSP Tool)
Solar Output
52.0%
52.0%
49.4%
49.4%
46.8%
45.5%
42.9%
41.6%
41.6%
41.6%
41.6%
40.3%
40.3%
39.0%
39.0%
37.7%
37.7%
37.7%
37.7%
36.4%
36.4%
36.4%
31.2%
31.2%
29.9%
28.6%
27.3%
26.0%
24.7%
15.6%
9.1%

70% At or Above Threshold (22/31 Observations)

70% Exceedance Threshold = 36.4%

30% Below Threshold (9/31 Observations)

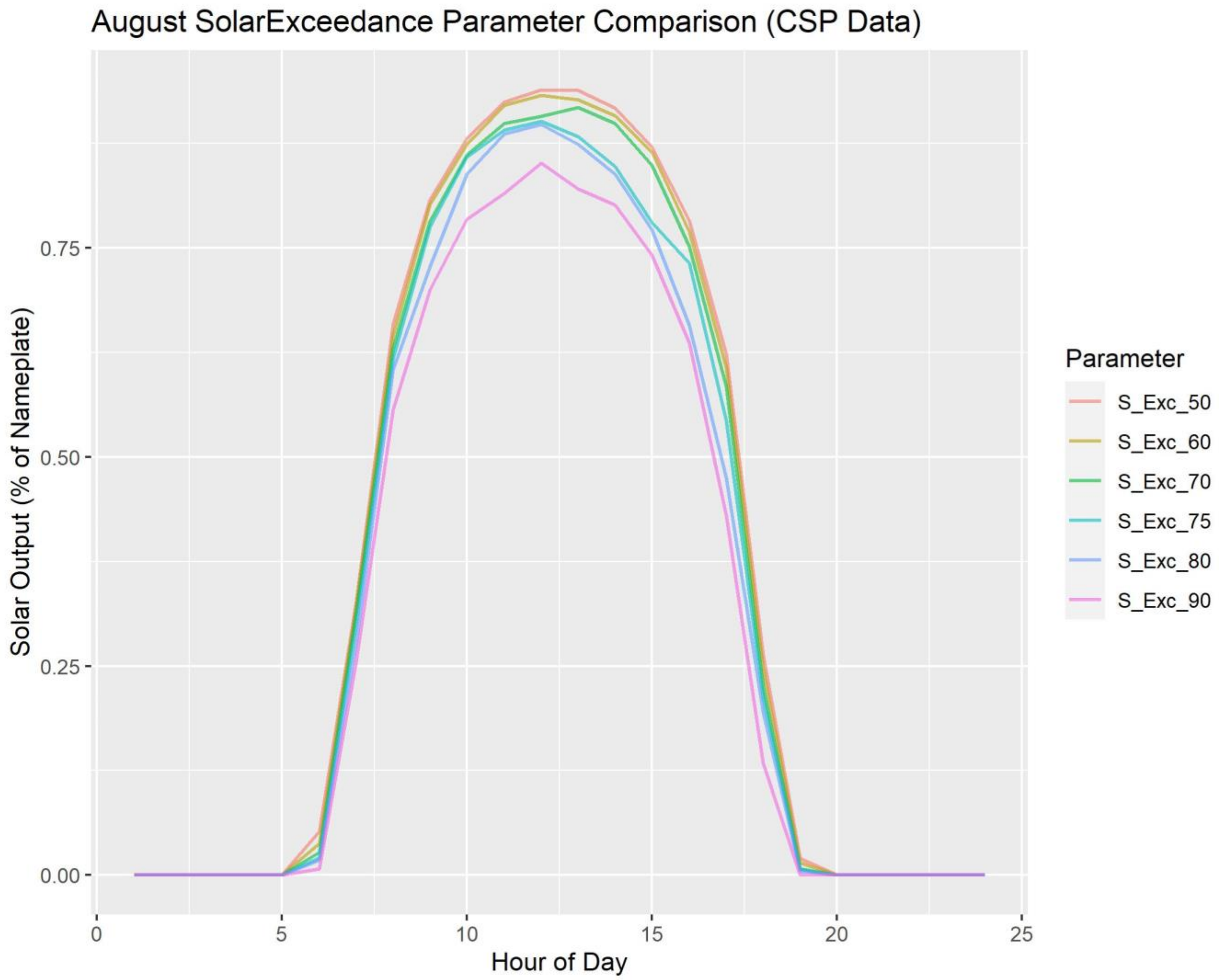


Data presented from 2022 Clean System Power Tool. Program should be calibrated from larger set of historical / modeled data.

Calibrating Exceedance

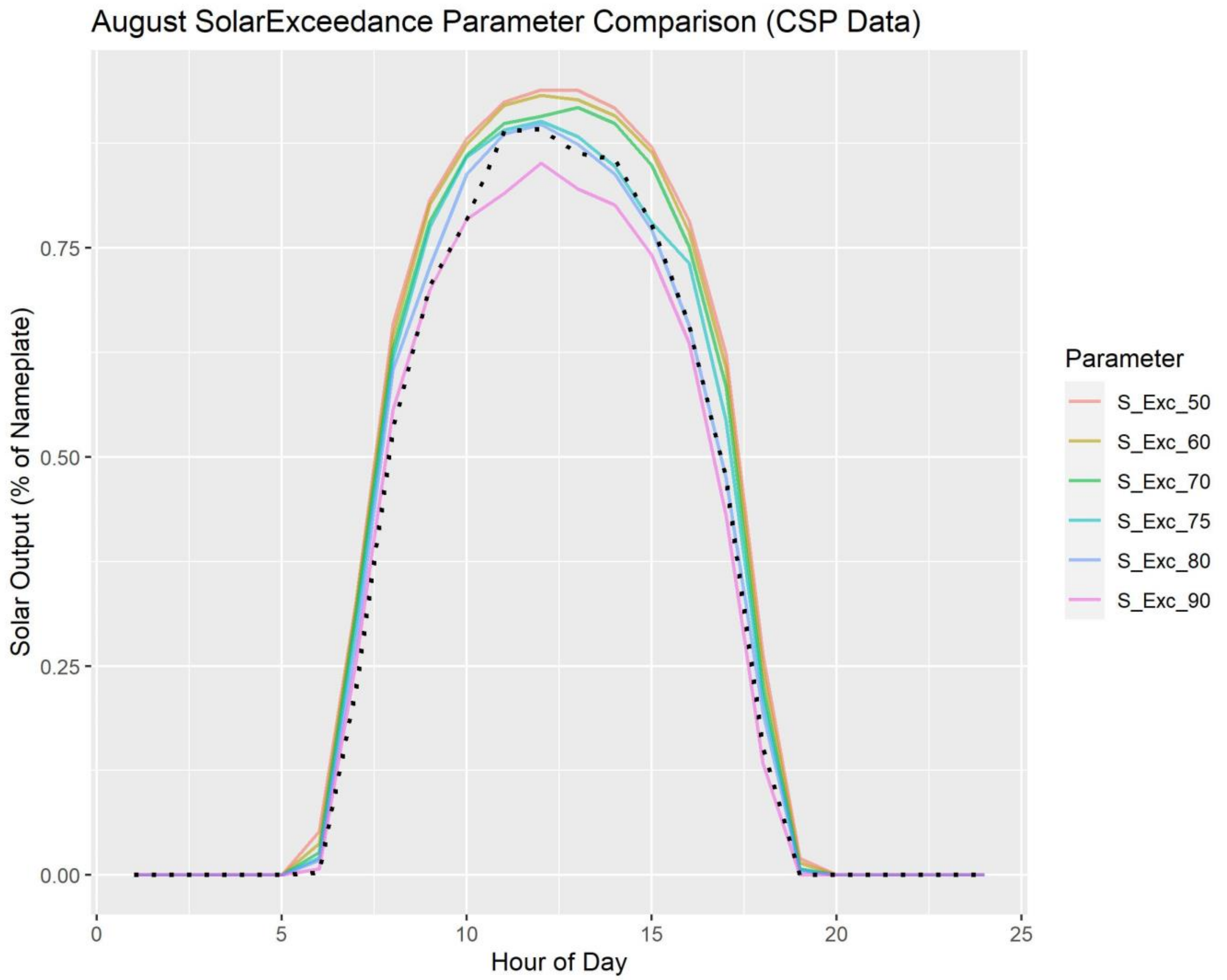
Peak Day Exceedance, Worst Day, and LOLE-Informed Methodologies

Calibrating Exceedance



- Exceedance needs to be calibrated using a specific input parameter – *this is a policy choice which should be informed by technical analysis.*
- Graphic at left illustrates exceedance at six exceedance thresholds from 50 to 90% using data from the IRP's Clean System Power Tool.
- Higher exceedance thresholds (e.g. 90%) will produce strictly lower profile results than lower exceedance thresholds (e.g. 50%)
- What is the "right" calibration metric? Subsequent slides explore the following methodologies:
  - Peak Day Calibration
  - Worst Day
  - LOLE-Informed

Calibrating Exceedance – Peak Day Approach



- D.22-06-035 directed the use of PG&E's proposed "Peak Day" methodology to calibrate the exceedance parameters
- Under this proposal, an exceedance parameter would be selected to align the shape and magnitude of the profile to the observed peak days across multiple years within the dataset
- The intent of this method is to reasonably approximate the output of solar and wind resources on peak load days
- Using the CSP "dummy data" reasonably supports an 80% exceedance threshold for peak hours, but the shape is not well aligned

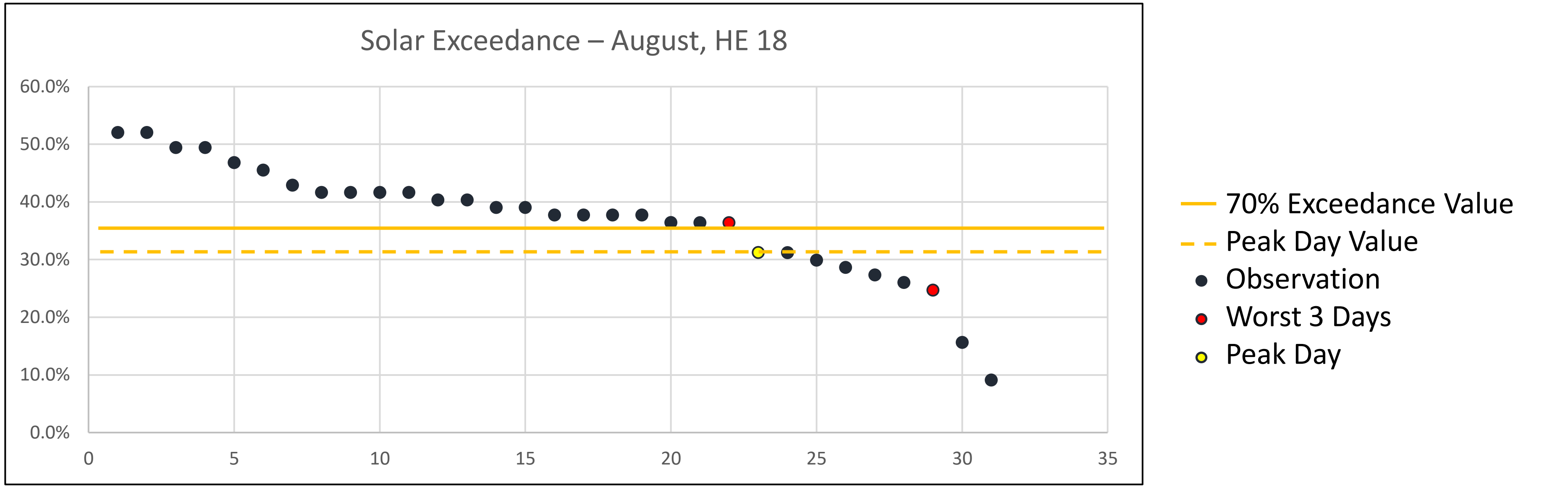
Peak Day Example: August, Hour 18

Solar Observations: August, Hour 18 (2022 CSP Tool)
Solar Output
52.0%
52.0%
49.4%
49.4%
46.8%
45.5%
42.9%
41.6%
41.6%
41.6%
41.6%
40.3%
40.3%
39.0%
39.0%
37.7%
37.7%
37.7%
37.7%
36.4%
36.4%
36.4%
31.2%
31.2%
29.9%
28.6%
27.3%
26.0%
24.7%
15.6%
9.1%

70% At or Above Threshold (22 of 31 Observations)

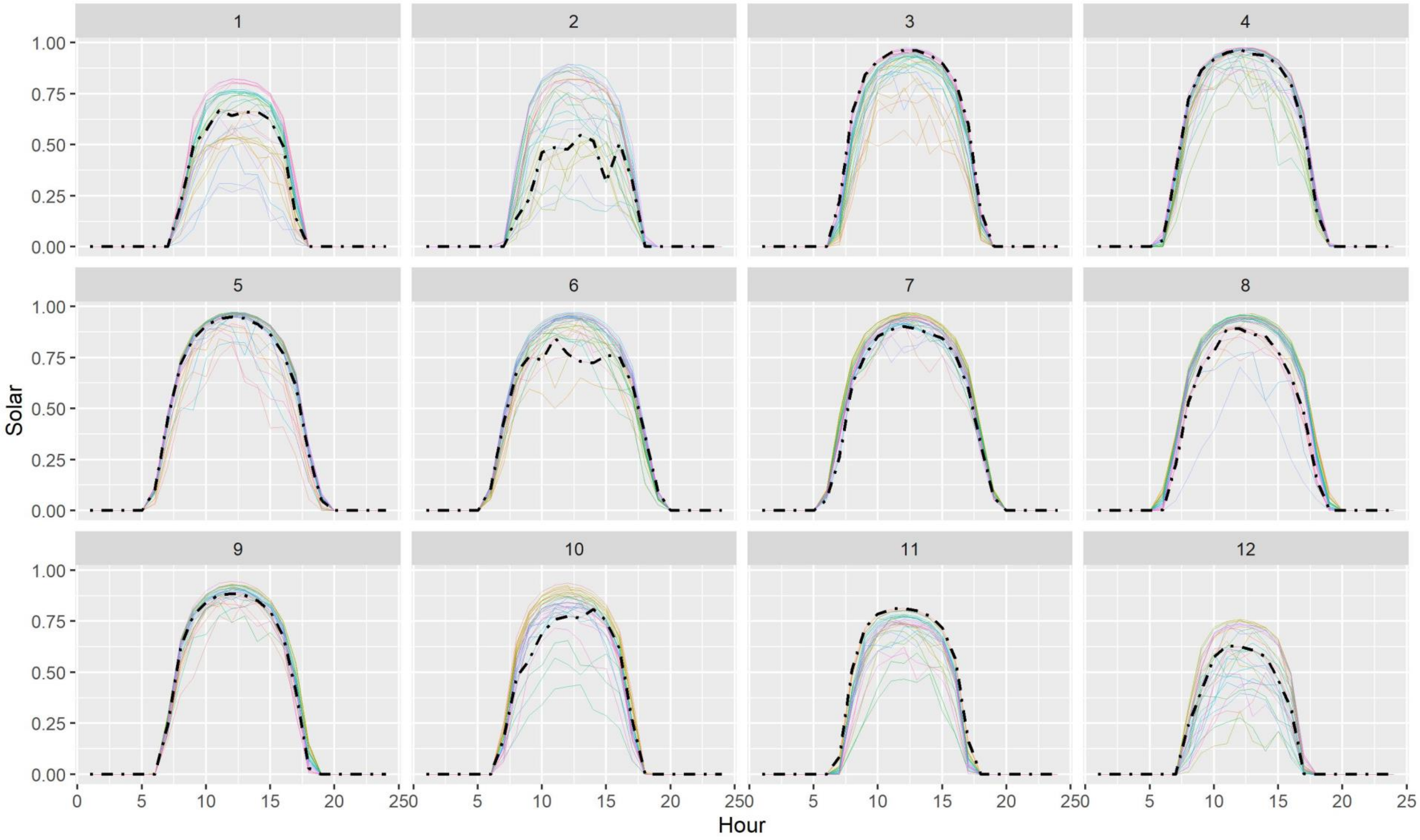
70% Exceedance Threshold = 36.4%

30% Below Threshold (9 of 31 Observations)

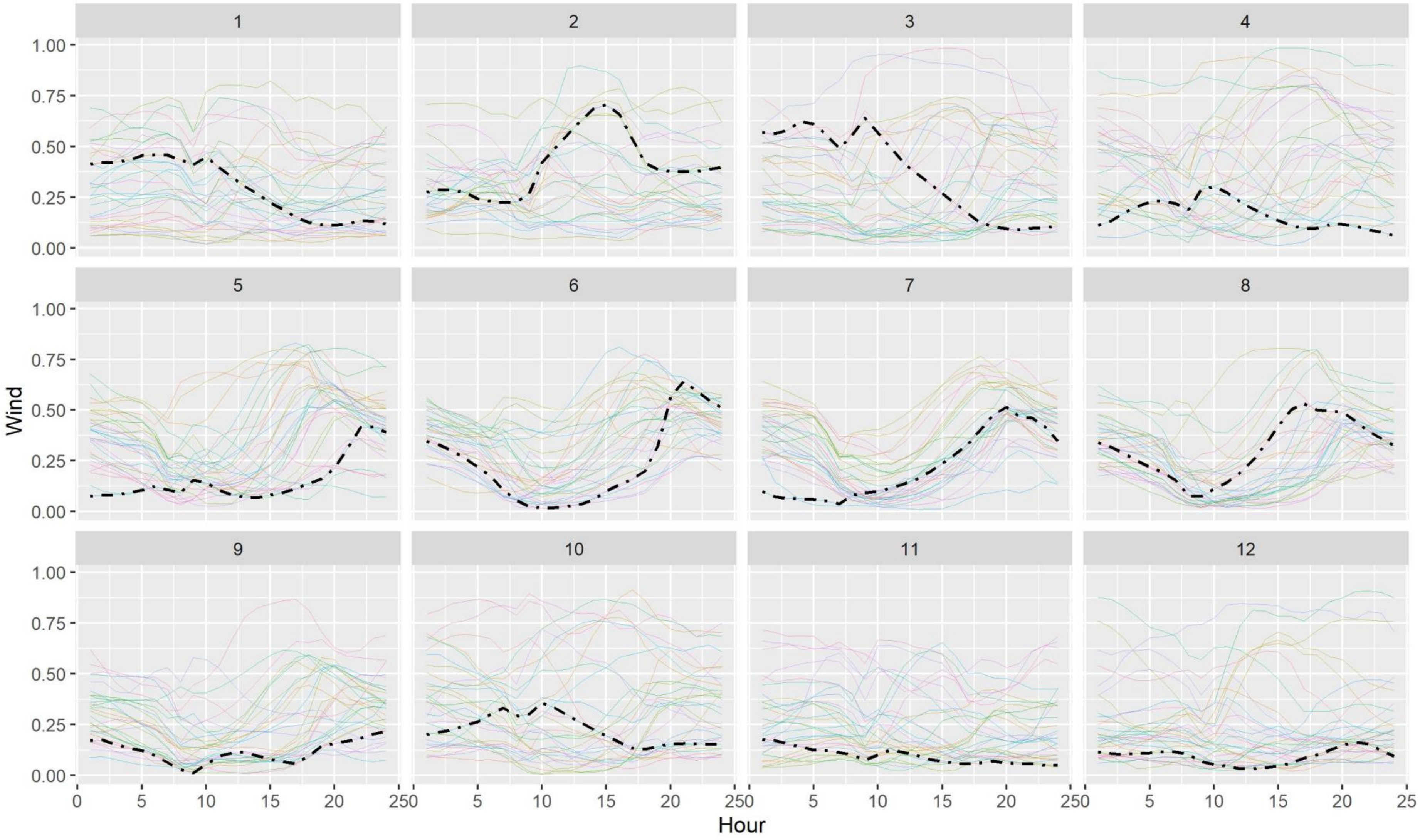


Data presented from 2022 Clean System Power Tool. Program should be calibrated from larger set of historical / modeled data.

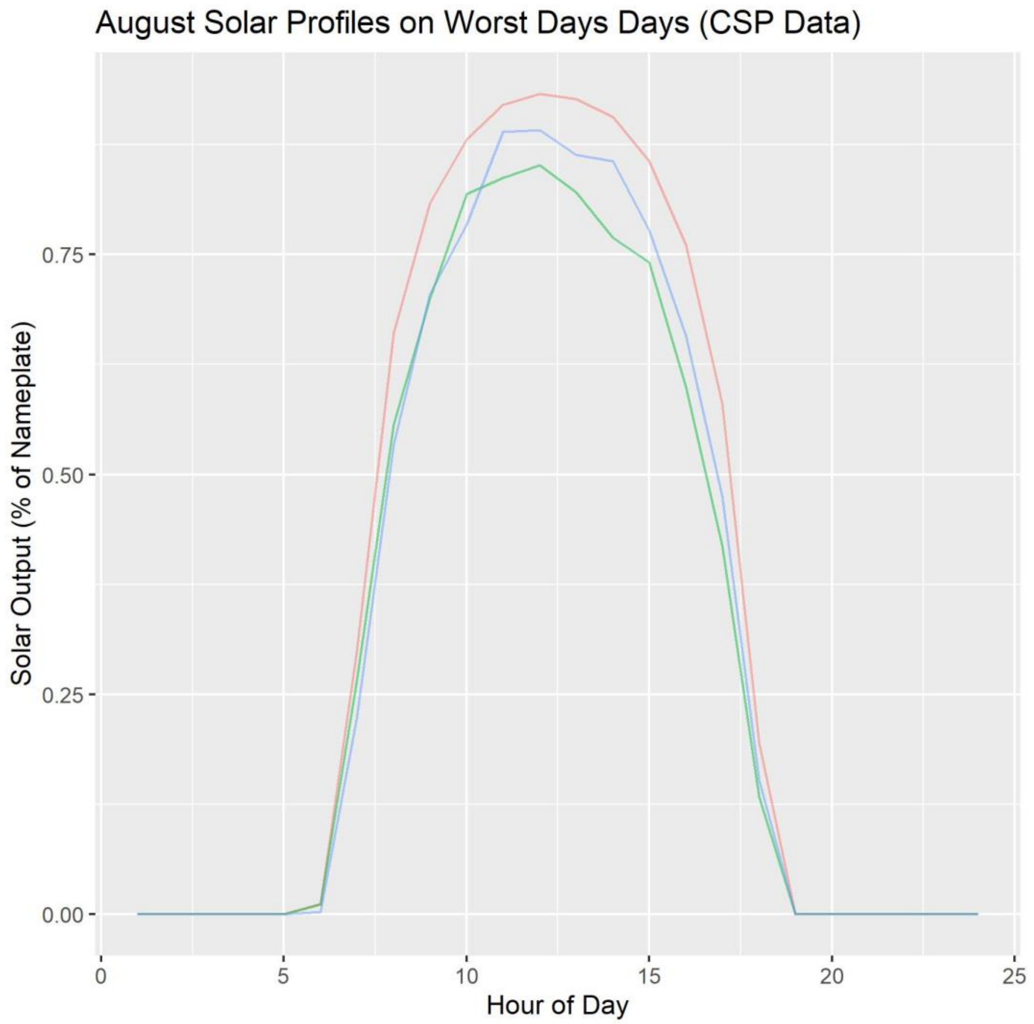
Peak Days - Solar



Peak Days - Wind



Worst Day Methodology



- To address shaping risk with exceedance, NRDC proposed the Worst Day methodology to draw directly from profiles / shapes from worst days

- Under the Worst Day methodology, NRDC proposed averaging a subset of worst days by peak or net peak
  - Days below a specific load or net load threshold would be excluded
  - Days above a specific load or net load threshold would be averaged

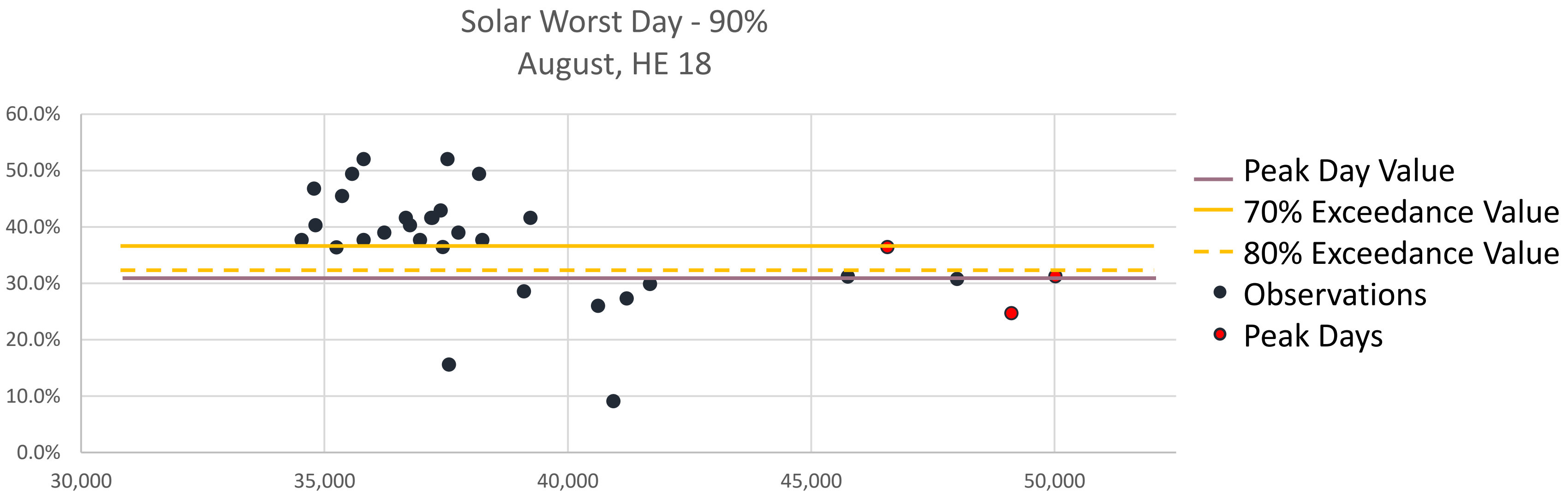
- This is intended to align shapes and magnitudes to the weather patterns driving peak load or net load days

Worst Day Example: August, Hour 18

Solar Observations: August, Hour 18 (2022 CSP Tool)	
Solar Output	Demand
37.7%	34,528
46.8%	34,783
40.3%	34,812
36.4%	35,246
45.5%	35,361
49.4%	35,567
37.7%	35,805
52.0%	35,807
39.0%	36,231
41.6%	36,672
40.3%	36,755
37.7%	36,961
41.6%	37,191
41.6%	37,218
42.9%	37,390
36.4%	37,431
52.0%	37,530
15.6%	37,556
39.0%	37,752
49.4%	38,174
37.7%	38,243
28.6%	39,095
41.6%	39,233
26.0%	40,622
9.1%	40,934
27.3%	41,209
29.9%	41,686
31.2%	45,755
36.4%	46,572
24.7%	49,119
31.2%	50,021

Low Load Days (**Excluded**)

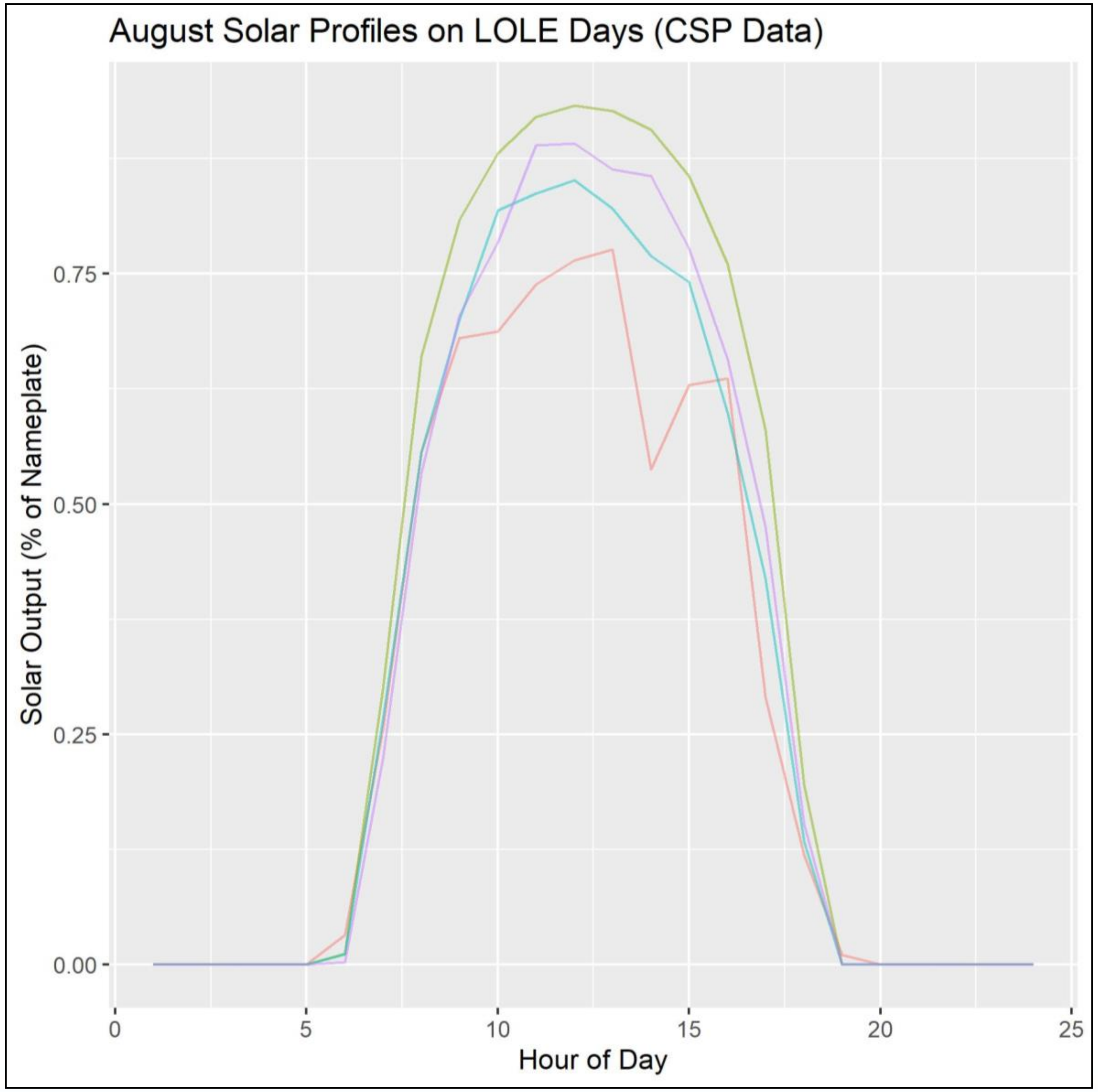
Peak Load Days (**Included**)



Average of Peak Load Days = 30.8%

Data presented from 2022 Clean System Power Tool. Program should be calibrated from larger set of historical / modeled data.

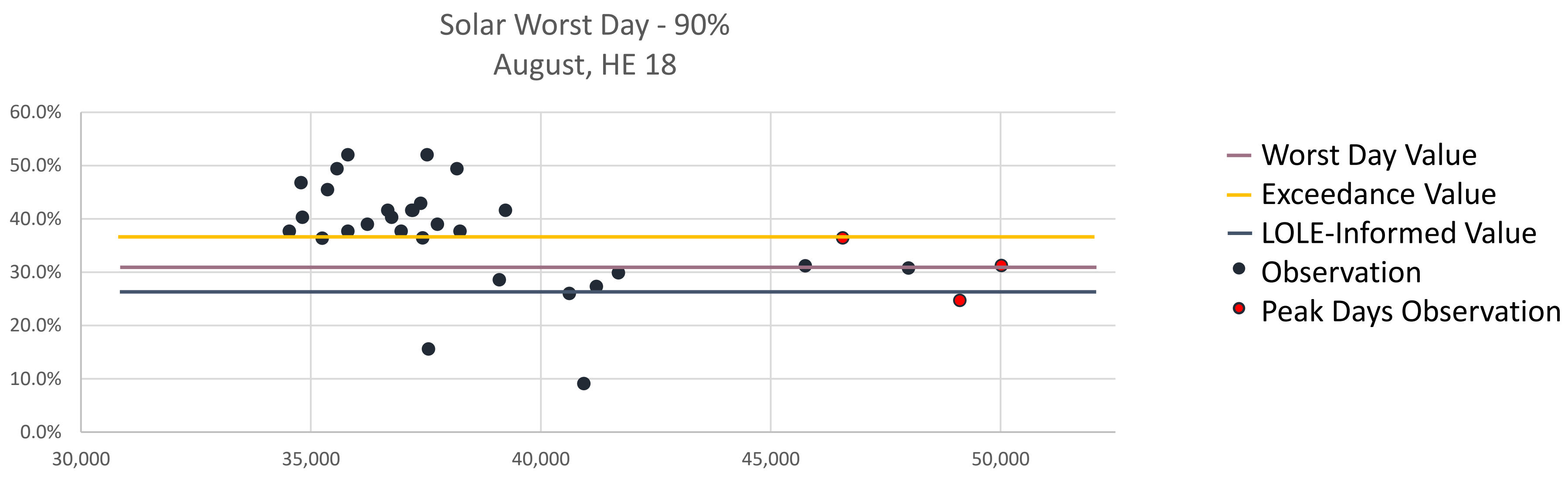
Exceedance Calibration – LOLE-Informed



- As the resource mix evolves, loss of load events may extend beyond peak / net peak load days
- Under the "LOLE-Informed" proposal, NRDC proposed the development of a synthetic profile representing the weighted average of values observed on Loss of Load Event days
  - Days without LOLE risk would be excluded
  - Days with LOLE risk would be averaged with weighting based on an LOLE metric (e.g. unserved energy)
- This approach would directly link the results of the LOLE study to the resource profiles

Worst Day Example: August, Hour 18

Solar Observations: August, Hour 18 (2022 CSP Tool)		
Solar Output	Demand	LOLE Weighting
37.7%	34,528	(Excluded)
46.8%	34,783	(Excluded)
40.3%	34,812	(Excluded)
36.4%	35,246	(Excluded)
45.5%	35,361	(Excluded)
49.4%	35,567	(Excluded)
37.7%	35,805	(Excluded)
52.0%	35,807	(Excluded)
39.0%	36,231	(Excluded)
41.6%	36,672	(Excluded)
40.3%	36,755	(Excluded)
37.7%	36,961	(Excluded)
41.6%	37,191	(Excluded)
41.6%	37,218	(Excluded)
42.9%	37,390	(Excluded)
36.4%	37,431	(Excluded)
52.0%	37,530	(Excluded)
15.6%	37,556	(Excluded)
39.0%	37,752	(Excluded)
49.4%	38,174	(Excluded)
37.7%	38,243	(Excluded)
28.6%	39,095	(Excluded)
41.6%	39,233	(Excluded)
26.0%	40,622	(Excluded)
9.1%	40,934	(Excluded)
27.3%	41,209	10.0%
29.9%	41,686	(Excluded)
31.2%	45,755	(Excluded)
36.4%	46,572	10.0%
24.7%	49,119	50.0%
31.2%	50,021	30.0%



LOLE Event Days (**Included**)

Weighted Average of LOLE Event Days = 28.1%

Data presented from 2022 Clean System Power Tool. Program should be calibrated from larger set of historical / modeled data. LOLE results are purely hypothetical; no LOLE data is provided with the CSP data.

Overview and Recommendations

	Exceedance (Peak Day)	Worst Day	LOLE-Informed Profiles
Overview	Statistical analysis of availability calibrated to align with expected production on highest load days	Profiles synthesized as average of observed "worst days" by load or net load in dataset	Profiles synthesized as weighted average of output on days experiencing LOLE events in LOLE model
Data Needs	Hourly resource dataset with demand data (modeled or historical)	Hourly resource dataset with demand data (modeled or historical)	Resource production and reliability observations output from LOLE model (modeled)
Pros	Simple and transparent to perform, incorporates correlation between resources and demand	Simple and transparent to perform, incorporates correlation between resources and demand, improves alignment of shapes relative to exceedance	Leverages robust LOLE modeling to align resource profiles with periods of reliability concerns
Cons	Exceedance values may not produce profiles that align shapes and magnitudes with peak day observations	Highest load / net load days may not reflect reliability periods of concern, e.g. moderate load days with poor resource output	Proprietary data, limited stakeholder transparency

Recommendations:

- NRDC supports continued development of the Peak Day calibration effort directed by D.22-06-050
- NRDC supports continued exploration of opportunities to leverage the Worst Day and LOLE-Informed methodologies into the resource counting calibration process
- NRDC supports frequent, robust program calibration to ensure any "error" introduced through counting is backstopped by the PRM calibration process

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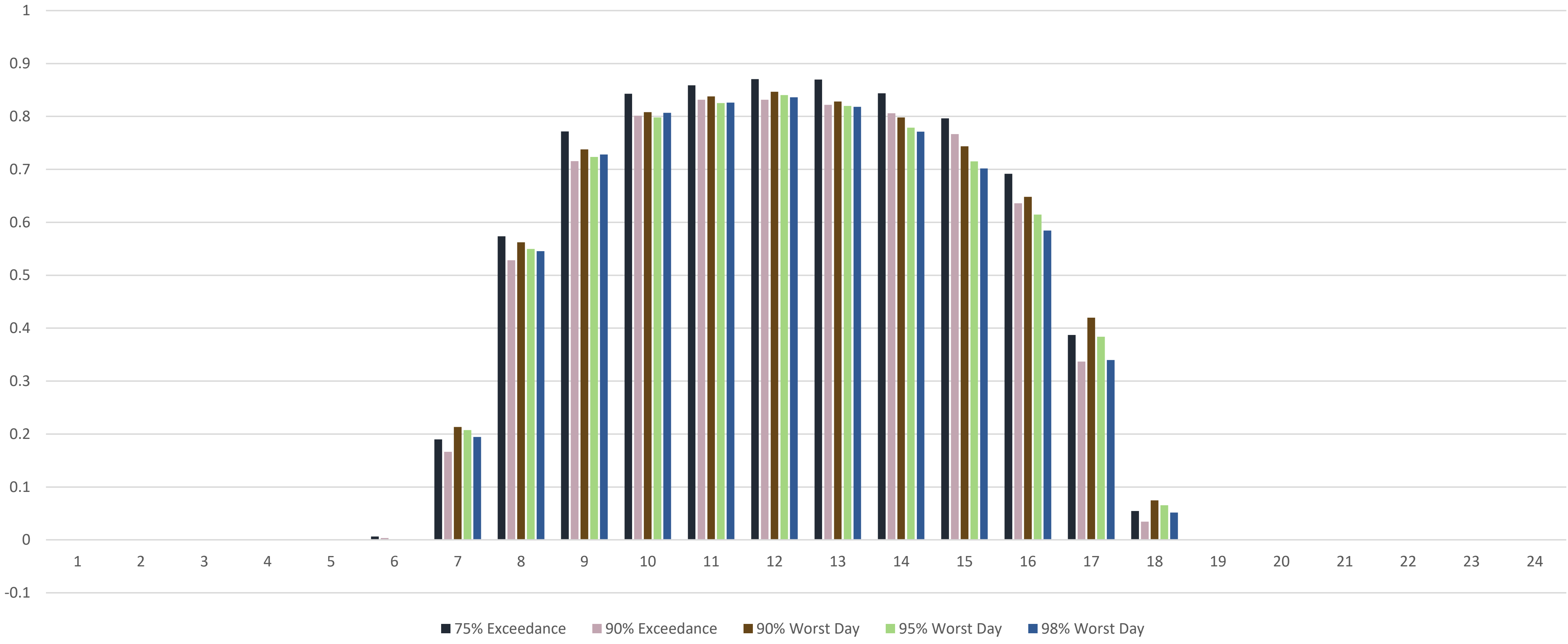
Appendix
2022 Resource Profiles Comparison Tool

Selected data from NRDC’s resource profiles comparison tool, submitted March 2022

Resource Counting Comparative: Solar in September



Note: All times PST (September HE 19 PST = HE 20 PDT)

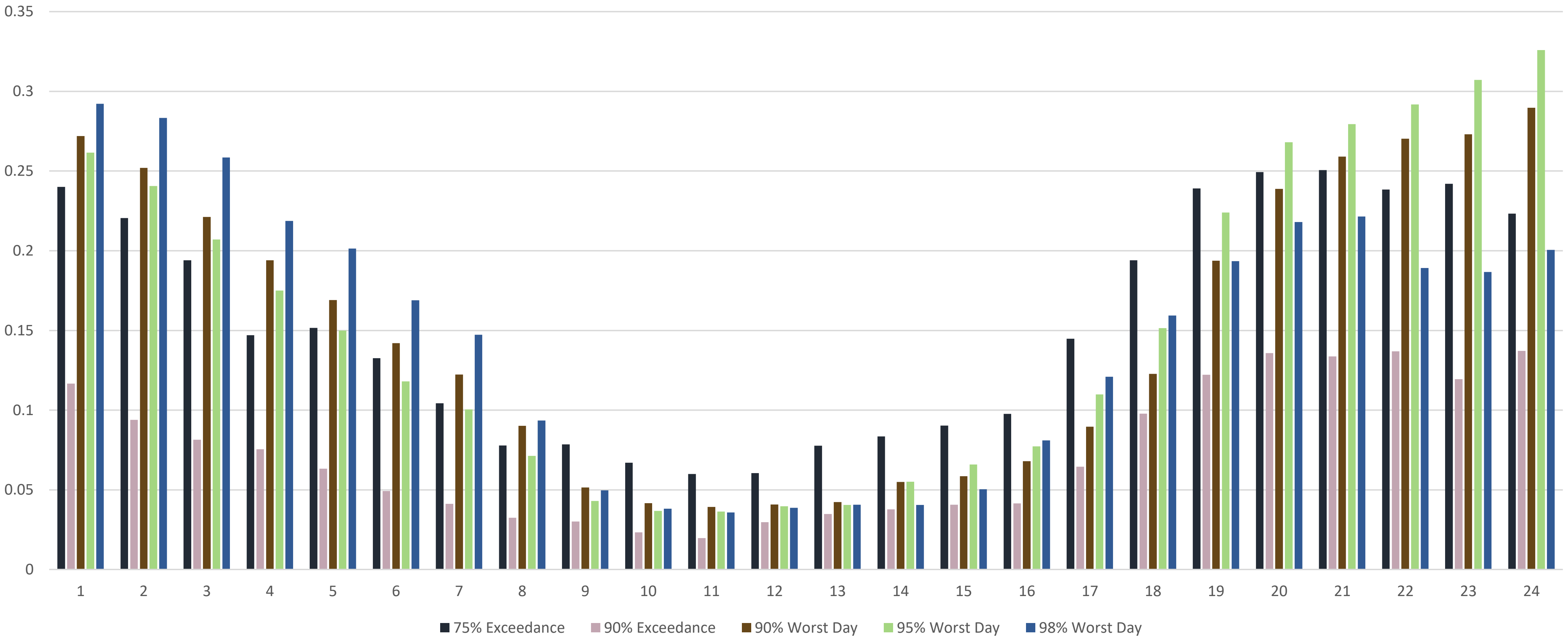
Solar Profiles: August and September

Month	Hour	NP_Solar_Exc_50	NP_Solar_Exc_60	NP_Solar_Exc_70	NP_Solar_Exc_75	NP_Solar_Exc_80	NP_Solar_Exc_90	GridPath_Solar_ WD-90%	GridPath_Solar_ WD-95%	GridPath_Solar_ WD-98%
8	1	0%	0%	0%	0%	0%	0%	0%	0%	0%
8	2	0%	0%	0%	0%	0%	0%	0%	0%	0%
8	3	0%	0%	0%	0%	0%	0%	0%	0%	0%
8	4	0%	0%	0%	0%	0%	0%	0%	0%	0%
8	5	0%	0%	0%	0%	0%	0%	0%	0%	0%
8	6	4%	3%	3%	3%	2%	2%	1%	1%	0%
8	7	33%	29%	28%	27%	27%	25%	26%	26%	26%
8	8	67%	63%	61%	60%	58%	54%	57%	57%	59%
8	9	82%	80%	78%	76%	75%	71%	73%	72%	74%
8	10	89%	88%	86%	85%	84%	80%	80%	79%	80%
8	11	93%	90%	90%	89%	88%	81%	85%	84%	83%
8	12	93%	91%	90%	89%	89%	83%	86%	85%	85%
8	13	92%	91%	89%	87%	86%	82%	83%	83%	83%
8	14	91%	89%	87%	86%	84%	81%	79%	80%	79%
8	15	87%	85%	83%	82%	79%	76%	73%	74%	74%
8	16	78%	76%	72%	71%	69%	66%	65%	65%	64%
8	17	59%	57%	56%	54%	53%	50%	51%	51%	48%
8	18	24%	23%	21%	20%	19%	18%	20%	20%	17%
8	19	2%	2%	1%	1%	1%	1%	1%	0%	0%
8	20	0%	0%	0%	0%	0%	0%	0%	0%	0%
8	21	0%	0%	0%	0%	0%	0%	0%	0%	0%
8	22	0%	0%	0%	0%	0%	0%	0%	0%	0%
8	23	0%	0%	0%	0%	0%	0%	0%	0%	0%
8	24	0%	0%	0%	0%	0%	0%	0%	0%	0%

Month	Hour	NP_Solar_Exc_50	NP_Solar_Exc_60	NP_Solar_Exc_70	NP_Solar_Exc_75	NP_Solar_Exc_80	NP_Solar_Exc_90	GridPath_Solar_ WD-90%	GridPath_Solar_ WD-95%	GridPath_Solar_ WD-98%
9	1	0%	0%	0%	0%	0%	0%	0%	0%	0%
9	2	0%	0%	0%	0%	0%	0%	0%	0%	0%
9	3	0%	0%	0%	0%	0%	0%	0%	0%	0%
9	4	0%	0%	0%	0%	0%	0%	0%	0%	0%
9	5	0%	0%	0%	0%	0%	0%	0%	0%	0%
9	6	1%	1%	1%	1%	1%	0%	0%	0%	0%
9	7	23%	22%	20%	19%	18%	17%	21%	21%	19%
9	8	62%	60%	58%	57%	55%	53%	56%	55%	55%
9	9	82%	80%	79%	77%	76%	72%	74%	72%	73%
9	10	89%	87%	86%	84%	83%	80%	81%	80%	81%
9	11	91%	90%	88%	86%	85%	83%	84%	83%	83%
9	12	91%	90%	87%	87%	86%	83%	85%	84%	84%
9	13	91%	90%	88%	87%	85%	82%	83%	82%	82%
9	14	90%	87%	86%	84%	83%	81%	80%	78%	77%
9	15	85%	82%	81%	80%	78%	77%	74%	72%	70%
9	16	74%	72%	70%	69%	68%	64%	65%	61%	58%
9	17	48%	45%	40%	39%	35%	34%	42%	38%	34%
9	18	10%	7%	6%	5%	5%	3%	7%	7%	5%
9	19	0%	0%	0%	0%	0%	0%	0%	0%	0%
9	20	0%	0%	0%	0%	0%	0%	0%	0%	0%
9	21	0%	0%	0%	0%	0%	0%	0%	0%	0%
9	22	0%	0%	0%	0%	0%	0%	0%	0%	0%
9	23	0%	0%	0%	0%	0%	0%	0%	0%	0%
9	24	0%	0%	0%	0%	0%	0%	0%	0%	0%

Note: All times PST (September HE 19 PST = HE 20 PDT)

Resource Counting Comparative: Wind in September



Note: All times PST (September HE 19 PST = HE 20 PDT)

Wind Profiles: August and September

Month	Hour	NP_Wind_Exc_50	NP_Wind_Exc_60	NP_Wind_Exc_70	NP_Wind_Exc_75	NP_Wind_Exc_80	NP_Wind_Exc_90	GridPath_Wind_WD-90%	GridPath_Wind_WD-95%	GridPath_Wind_WD-98%
8	1	49%	47%	42%	41%	40%	33%	34%	30%	16%
8	2	45%	43%	41%	40%	37%	30%	32%	27%	15%
8	3	42%	39%	37%	36%	35%	28%	29%	24%	14%
8	4	37%	36%	34%	32%	31%	26%	25%	20%	14%
8	5	35%	33%	31%	30%	28%	21%	22%	17%	13%
8	6	31%	30%	27%	25%	22%	16%	19%	14%	12%
8	7	25%	24%	21%	20%	18%	14%	15%	11%	9%
8	8	20%	19%	16%	13%	12%	10%	9%	6%	6%
8	9	16%	16%	11%	11%	9%	5%	6%	4%	4%
8	10	15%	11%	10%	9%	7%	4%	5%	4%	4%
8	11	14%	11%	9%	8%	6%	4%	5%	4%	4%
8	12	15%	12%	10%	8%	6%	4%	5%	3%	3%
8	13	19%	15%	12%	10%	7%	5%	5%	4%	3%
8	14	24%	21%	17%	14%	10%	8%	6%	4%	4%
8	15	30%	26%	22%	21%	19%	12%	8%	6%	6%
8	16	40%	34%	31%	29%	26%	17%	11%	9%	8%
8	17	44%	39%	36%	34%	32%	22%	13%	10%	8%
8	18	47%	45%	40%	39%	36%	25%	17%	15%	13%
8	19	52%	46%	44%	42%	40%	31%	22%	19%	15%
8	20	53%	51%	46%	45%	43%	38%	30%	26%	20%
8	21	54%	50%	47%	46%	44%	39%	32%	28%	22%
8	22	51%	49%	47%	45%	44%	38%	33%	28%	22%
8	23	51%	49%	46%	44%	42%	37%	32%	28%	23%
8	24	51%	48%	45%	43%	42%	34%	32%	28%	23%

Month	Hour	NP_Wind_Exc_50	NP_Wind_Exc_60	NP_Wind_Exc_70	NP_Wind_Exc_75	NP_Wind_Exc_80	NP_Wind_Exc_90	GridPath_Wind_WD-90%	GridPath_Wind_WD-95%	GridPath_Wind_WD-98%
9	1	37%	32%	30%	24%	21%	12%	27%	26%	29%
9	2	35%	30%	27%	22%	19%	9%	25%	24%	28%
9	3	32%	28%	23%	19%	15%	8%	22%	21%	26%
9	4	28%	24%	18%	15%	12%	8%	19%	18%	22%
9	5	25%	20%	18%	15%	11%	6%	17%	15%	20%
9	6	23%	19%	15%	13%	10%	5%	14%	12%	17%
9	7	19%	17%	14%	10%	7%	4%	12%	10%	15%
9	8	16%	14%	11%	8%	6%	3%	9%	7%	9%
9	9	16%	11%	9%	8%	6%	3%	5%	4%	5%
9	10	12%	10%	8%	7%	6%	2%	4%	4%	4%
9	11	11%	10%	8%	6%	5%	2%	4%	4%	4%
9	12	13%	11%	7%	6%	5%	3%	4%	4%	4%
9	13	15%	10%	8%	8%	5%	3%	4%	4%	4%
9	14	18%	11%	10%	8%	6%	4%	5%	6%	4%
9	15	22%	17%	11%	9%	6%	4%	6%	7%	5%
9	16	27%	20%	13%	10%	9%	4%	7%	8%	8%
9	17	29%	24%	18%	14%	11%	6%	9%	11%	12%
9	18	33%	27%	21%	19%	17%	10%	12%	15%	16%
9	19	39%	34%	27%	24%	20%	12%	19%	22%	19%
9	20	41%	35%	28%	25%	22%	14%	24%	27%	22%
9	21	41%	34%	28%	25%	22%	13%	26%	28%	22%
9	22	39%	33%	27%	24%	22%	14%	27%	29%	19%
9	23	38%	32%	26%	24%	20%	12%	27%	31%	19%
9	24	39%	34%	30%	22%	21%	14%	29%	33%	20%

Note: All times PST (September HE 19 PST = HE 20 PDT)