Resource Counting: Solar and Wind

July 27, 2022

Together, Building
a Better California

Agenda

1. PG&E Proposal on Exceedance for Solar and Wind

2. Comparison to Other Proposals

3. Key Issues / Questions

D.21-07-014 Principles Relevant for Wind and Solar Counting

1. Balance a Reliable Electrical Grid with Minimizing Costs to Customers
2. Balance Addressing Hourly Energy Sufficiency with Advancing Environmental Goals
3. Balance Granularity in Meeting Hourly Needs with Simplicity and Transactability
4. Implementable in the Near-Term
5. To be Durable and Adaptable to a Changing Electric Grid

PG&E Proposal: Solar & Wind

PG&E Proposal

PG&E approach is an **exceedance-based methodology** for solar and wind that uses solar and wind performance on stressed grid days to determine an appropriate exceedance level. Final levels should be determined as part of PRM modeling.

Proposal Parameters

- **Data**: Several years of data (2015-2020 in PG&E dataset)
  - PG&E weights all years equally, but open to discussion on this (e.g., worst year receives greater weighting in hydro methodology)
- **Simplicity**: The exceedance level should **remain constant** across all hours (e.g., some hours should not have a 50% exceedance level while others have a 75% exceedance level)
  - A variable exceedance level creates additional complexity (e.g., How often are levels updated? Are hours changing every year?)

Determining Exceedance Level

Review solar and wind performance under stressed grid conditions

- PG&E's initial proposal looked at performance on the peak load day each month in the dataset (6 years of data resulted in 6 datapoints for each month)
- PG&E has expanded this following stakeholder feedback to the top 5 load days each month (30 datapoints for each month over a 6-year dataset)

Process

1. Identify the top 5 peak load days in each month during the historical period
2. Review solar and wind performance during those days and convert to capacity factors using installed capacity at the time
3. Average data across all years to arrive at a peak load day profile
4. Set up exceedance profiles that can be easily adjusted or optimized
5. Compare the peak load day performance to the exceedance production at each level
6. Select the exceedance level that best matches the peak load day profile

Exceedance Analysis - Solar

Steps 1-3: Average solar generation on worst days (2015-2020, capacity factor)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Jan	0%	0%	0%	0%	0%	0%	0%	7%	30%	45%	51%	51%	51%	48%	42%	29%	7%	0%	0%	0%	0%	0%	0%	0%
Feb	0%	0%	0%	0%	0%	0%	0%	16%	45%	60%	66%	66%	66%	65%	60%	48%	21%	2%	0%	0%	0%	0%	0%	0%
Mar	0%	0%	0%	0%	0%	0%	2%	21%	50%	67%	74%	76%	76%	74%	71%	64%	45%	20%	4%	0%	0%	0%	0%	0%
Apr	0%	0%	0%	0%	0%	0%	4%	31%	64%	79%	87%	89%	90%	90%	88%	83%	73%	54%	21%	2%	0%	0%	0%	0%
May	0%	0%	0%	0%	0%	0%	10%	42%	68%	81%	87%	87%	91%	90%	88%	84%	76%	60%	30%	4%	0%	0%	0%	0%
Jun	0%	0%	0%	0%	0%	0%	12%	42%	65%	77%	84%	86%	87%	85%	84%	79%	71%	58%	34%	8%	0%	0%	0%	0%
Jul	0%	0%	0%	0%	0%	0%	6%	31%	56%	69%	77%	80%	80%	79%	77%	70%	63%	51%	28%	6%	0%	0%	0%	0%
Aug	0%	0%	0%	0%	0%	0%	2%	23%	52%	68%	73%	80%	80%	79%	76%	69%	61%	46%	19%	2%	0%	0%	0%	0%
Sep	0%	0%	0%	0%	0%	0%	1%	17%	48%	66%	74%	77%	77%	76%	72%	65%	55%	34%	8%	0%	0%	0%	0%	0%
Oct	0%	0%	0%	0%	0%	0%	0%	9%	40%	62%	70%	72%	72%	72%	70%	64%	48%	16%	1%	0%	0%	0%	0%	0%
Nov	0%	0%	0%	0%	0%	0%	2%	22%	49%	61%	63%	63%	64%	62%	53%	33%	6%	1%	0%	0%	0%	0%	0%	0%
Dec	0%	0%	0%	0%	0%	0%	0%	9%	33%	47%	51%	52%	52%	49%	42%	23%	2%	0%	0%	0%	0%	0%	0%	0%

Step 4: Exceedance production at **50% level** (2015-2020, capacity factor)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Jan	0%	0%	0%	0%	0%	0%	0%	8%	32%	48%	53%	56%	56%	55%	48%	32%	7%	0%	0%	0%	0%	0%	0%	0%
Feb	0%	0%	0%	0%	0%	0%	0%	18%	51%	67%	71%	71%	70%	71%	66%	53%	25%	2%	0%	0%	0%	0%	0%	0%
Mar	0%	0%	0%	0%	0%	0%	0%	11%	44%	66%	73%	76%	75%	74%	71%	65%	49%	32%	7%	0%	0%	0%	0%	0%
Apr	0%	0%	0%	0%	0%	0%	2%	24%	55%	73%	79%	81%	82%	81%	80%	76%	68%	50%	17%	1%	0%	0%	0%	0%
May	0%	0%	0%	0%	0%	0%	9%	39%	64%	77%	84%	85%	86%	85%	83%	79%	71%	57%	28%	4%	0%	0%	0%	0%
Jun	0%	0%	0%	0%	0%	0%	13%	44%	68%	80%	86%	89%	90%	89%	87%	83%	76%	63%	37%	9%	0%	0%	0%	0%
Jul	0%	0%	0%	0%	0%	0%	7%	34%	60%	75%	81%	86%	86%	85%	84%	80%	73%	60%	35%	7%	0%	0%	0%	0%
Aug	0%	0%	0%	0%	0%	0%	2%	26%	56%	72%	81%	85%	85%	85%	83%	78%	69%	52%	22%	2%	0%	0%	0%	0%
Sep	0%	0%	0%	0%	0%	0%	0%	17%	52%	71%	78%	81%	81%	81%	79%	74%	64%	38%	7%	0%	0%	0%	0%	0%
Oct	0%	0%	0%	0%	0%	0%	0%	8%	40%	63%	71%	74%	74%	74%	73%	67%	50%	15%	0%	0%	0%	0%	0%	0%
Nov	0%	0%	0%	0%	0%	0%	1%	21%	49%	61%	65%	65%	64%	63%	56%	31%	4%	0%	0%	0%	0%	0%	0%	0%
Dec	0%	0%	0%	0%	0%	0%	0%	9%	33%	48%	53%	53%	53%	51%	44%	24%	2%	0%	0%	0%	0%	0%	0%	0%

Step 5: Difference between the exceedance and peak load day production

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Jan	0%	0%	0%	0%	0%	0%	0%	1%	2%	3%	2%	5%	5%	7%	6%	4%	0%	0%	0%	0%	0%	0%	0%	0%
Feb	0%	0%	0%	0%	0%	0%	0%	2%	7%	7%	5%	4%	4%	6%	6%	5%	4%	0%	0%	0%	0%	0%	0%	0%
Mar	0%	0%	0%	0%	0%	0%	-2%	-9%	-7%	-1%	-1%	0%	-1%	-1%	0%	1%	5%	12%	2%	0%	0%	0%	0%	0%
Apr	0%	0%	0%	0%	0%	0%	-2%	-7%	-9%	-6%	-8%	-9%	-8%	-8%	-8%	-7%	-6%	-5%	-4%	-1%	0%	0%	0%	0%
May	0%	0%	0%	0%	0%	0%	-1%	-3%	-4%	-4%	-3%	-1%	-5%	-5%	-5%	-5%	-5%	-3%	-2%	-1%	0%	0%	0%	0%
Jun	0%	0%	0%	0%	0%	0%	1%	2%	2%	3%	2%	2%	3%	4%	3%	4%	5%	5%	3%	0%	0%	0%	0%	0%
Jul	0%	0%	0%	0%	0%	0%	1%	3%	5%	5%	5%	6%	5%	6%	7%	10%	10%	9%	6%	2%	0%	0%	0%	0%
Aug	0%	0%	0%	0%	0%	0%	0%	3%	5%	4%	8%	5%	5%	6%	7%	9%	8%	6%	3%	0%	0%	0%	0%	0%
Sep	0%	0%	0%	0%	0%	0%	0%	0%	3%	4%	4%	4%	4%	6%	8%	9%	9%	3%	-1%	0%	0%	0%	0%	0%
Oct	0%	0%	0%	0%	0%	0%	0%	-1%	0%	1%	1%	2%	2%	2%	2%	3%	2%	-2%	0%	0%	0%	0%	0%	0%
Nov	0%	0%	0%	0%	0%	0%	-1%	-2%	0%	1%	2%	2%	0%	2%	3%	-2%	-2%	-1%	0%	0%	0%	0%	0%	0%
Dec	0%	0%	0%	0%	0%	0%	0%	0%	0%	2%	2%	1%	1%	1%	1%	1%	0%	0%	0%	0%	0%	0%	0%	0%

- **Negative values (green)** indicates that **less solar is counted** in that exceedance level than expected from the peak load day analysis
- **Positive values (red)** indicates that **more solar is counted** in that exceedance level than expected from the peak load day analysis

Exceedance Analysis - Solar

Step 6: What is the right exceedance level?

- No positive (red) values in any month? In summer months?
- Very few positive (red) values?

- PG&E has provided options to test in the PRM analysis, which we believe should be the venue that ultimately decides the appropriate level
  - Note that results of the PRM analysis might suggest higher or lower levels than provided below
  - Note that we did not have access to solar technology type data (tracking v. fixed); the following is all solar, but further refinement should be pursued by technology type

- 89% is level required to have no positive values May-Oct (4 decimal places)

Avg Worst Day vs Exceedance

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Jan	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-0.01%	-4.75%	-18.02%	-19.45%	-18.84%	-17.19%	-17.54%	-21.52%	-20.97%	-16.27%	-4.69%	-0.11%	-0.01%	-0.01%	-0.01%	-0.01%	-0.01%	0.00%
Feb	-0.01%	-0.01%	-0.01%	0.00%	0.00%	0.00%	-0.44%	-6.42%	-13.70%	-16.19%	-14.76%	-14.61%	-17.04%	-20.38%	-21.61%	-20.23%	-9.70%	-1.20%	-0.04%	-0.01%	-0.01%	-0.01%	-0.01%	-0.01%
Mar	-0.01%	-0.01%	-0.01%	0.00%	-0.01%	0.00%	-2.15%	-15.80%	-25.43%	-28.56%	-24.83%	-23.00%	-23.52%	-23.63%	-23.52%	-26.56%	-20.61%	-15.78%	-4.11%	-0.16%	-0.13%	-0.06%	-0.01%	-0.01%
Apr	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-3.30%	-16.31%	-23.80%	-23.85%	-27.15%	-27.14%	-25.81%	-28.70%	-30.69%	-30.63%	-27.72%	-21.85%	-11.11%	-1.43%	-0.14%	-0.02%	0.00%	0.00%
May	-0.44%	-0.36%	-0.31%	-0.31%	-0.07%	-0.02%	-5.19%	-16.35%	-20.58%	-22.75%	-23.04%	-19.41%	-21.07%	-23.80%	-26.06%	-25.32%	-23.41%	-22.08%	-13.83%	-2.41%	-0.04%	-0.02%	-0.02%	-0.01%
Jun	-0.04%	-0.04%	-0.04%	-0.04%	-0.04%	-0.11%	-3.01%	-9.53%	-12.00%	-12.34%	-10.73%	-11.36%	-10.16%	-9.72%	-9.31%	-10.34%	-11.24%	-9.99%	-8.03%	-2.77%	-0.15%	-0.02%	0.00%	0.00%
Jul	-0.02%	-0.02%	-0.02%	-0.02%	-0.02%	-0.02%	-2.05%	-7.11%	-8.08%	-7.25%	-6.32%	-4.58%	-3.05%	-3.84%	-3.17%	-0.25%	-1.87%	-2.69%	-2.97%	-1.62%	-0.07%	-0.05%	-0.02%	-0.02%
Aug	-0.04%	-0.03%	-0.03%	-0.03%	-0.03%	-0.03%	-1.02%	-5.15%	-8.11%	-9.56%	-4.51%	-7.12%	-6.96%	-7.34%	-6.77%	-6.00%	-5.38%	-7.31%	-4.92%	-1.31%	-0.11%	-0.11%	-0.09%	-0.05%
Sep	-0.01%	-0.01%	-0.01%	0.00%	0.00%	0.00%	-0.50%	-5.59%	-12.29%	-12.47%	-10.36%	-10.71%	-9.62%	-8.54%	-8.32%	-10.75%	-11.52%	-10.00%	-5.24%	-0.25%	-0.11%	-0.09%	-0.09%	-0.05%
Oct	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-0.01%	-4.64%	-11.73%	-14.22%	-11.86%	-11.75%	-12.11%	-11.02%	-14.28%	-14.39%	-14.07%	-8.37%	-0.75%	-0.07%	-0.02%	0.00%	0.00%	0.00%
Nov	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-1.78%	-13.78%	-18.71%	-18.83%	-17.45%	-13.87%	-16.02%	-17.28%	-18.31%	-15.20%	-4.55%	-0.50%	-0.06%	-0.05%	-0.05%	-0.03%	-0.03%	-0.01%
Dec	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-0.06%	-5.60%	-15.48%	-20.39%	-19.86%	-17.10%	-17.24%	-18.55%	-17.17%	-11.52%	-1.44%	-0.01%	-0.01%	-0.01%	-0.01%	-0.01%	0.00%	0.00%

Note that the data does not adjust for curtailments which could bias the capacity values downward; we plan to consider further refinements

Exceedance Analysis - Solar

- 89% is level required to have no positive values (2 decimal places)

Avg Worst Day vs Exceedance

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Jan	0%	0%	0%	0%	0%	0%	0%	-5%	-18%	-19%	-18%	-15%	-16%	-18%	-20%	-16%	-5%	0%	0%	0%	0%	0%	0%	0%
Feb	0%	0%	0%	0%	0%	0%	0%	-6%	-13%	-15%	-15%	-14%	-15%	-19%	-20%	-20%	-9%	-1%	0%	0%	0%	0%	0%	0%
Mar	0%	0%	0%	0%	0%	0%	-2%	-16%	-25%	-28%	-24%	-21%	-23%	-21%	-21%	-25%	-20%	-16%	-4%	0%	0%	0%	0%	0%
Apr	0%	0%	0%	0%	0%	0%	-3%	-16%	-23%	-23%	-27%	-26%	-25%	-27%	-30%	-30%	-27%	-21%	-11%	-1%	0%	0%	0%	0%
May	0%	0%	0%	0%	0%	0%	-5%	-15%	-20%	-21%	-23%	-18%	-21%	-22%	-26%	-24%	-22%	-21%	-13%	-2%	0%	0%	0%	0%
Jun	0%	0%	0%	0%	0%	0%	-3%	-9%	-12%	-10%	-10%	-11%	-10%	-9%	-9%	-10%	-11%	-9%	-8%	-3%	0%	0%	0%	0%
Jul	0%	0%	0%	0%	0%	0%	-2%	-7%	-8%	-6%	-5%	-4%	-2%	-3%	-3%	0%	-1%	-2%	-2%	-1%	0%	0%	0%	0%
Aug	0%	0%	0%	0%	0%	0%	-1%	-5%	-7%	-9%	-4%	-7%	-6%	-7%	-6%	-5%	-5%	-7%	-5%	-1%	0%	0%	0%	0%
Sep	0%	0%	0%	0%	0%	0%	-1%	-5%	-12%	-12%	-10%	-10%	-8%	-8%	-8%	-9%	-10%	-10%	-5%	0%	0%	0%	0%	0%
Oct	0%	0%	0%	0%	0%	0%	0%	-5%	-11%	-13%	-11%	-11%	-12%	-10%	-13%	-14%	-14%	-8%	-1%	0%	0%	0%	0%	0%
Nov	0%	0%	0%	0%	0%	0%	-2%	-13%	-19%	-18%	-16%	-13%	-16%	-17%	-17%	-14%	-4%	-1%	0%	0%	0%	0%	0%	0%
Dec	0%	0%	0%	0%	0%	0%	0%	-5%	-15%	-20%	-19%	-16%	-16%	-16%	-16%	-11%	-1%	0%	0%	0%	0%	0%	0%	0%

- 82% is level required to have difference of 2% or less in all hours (coincides with summer months)

Avg Worst Day vs Exceedance

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Jan	0%	0%	0%	0%	0%	0%	0%	-3%	-13%	-14%	-11%	-11%	-9%	-12%	-14%	-11%	-4%	0%	0%	0%	0%	0%	0%	0%
Feb	0%	0%	0%	0%	0%	0%	0%	-3%	-7%	-11%	-10%	-11%	-12%	-14%	-12%	-12%	-5%	-1%	0%	0%	0%	0%	0%	0%
Mar	0%	0%	0%	0%	0%	0%	-2%	-15%	-20%	-19%	-17%	-18%	-16%	-17%	-18%	-19%	-17%	-14%	-4%	0%	0%	0%	0%	0%
Apr	0%	0%	0%	0%	0%	0%	-3%	-15%	-20%	-19%	-22%	-23%	-22%	-23%	-25%	-24%	-21%	-18%	-9%	-1%	0%	0%	0%	0%
May	0%	0%	0%	0%	0%	0%	-4%	-12%	-17%	-18%	-17%	-15%	-18%	-19%	-17%	-17%	-19%	-16%	-10%	-2%	0%	0%	0%	0%
Jun	0%	0%	0%	0%	0%	0%	-2%	-7%	-8%	-8%	-7%	-7%	-7%	-7%	-7%	-6%	-6%	-6%	-6%	-2%	0%	0%	0%	0%
Jul	0%	0%	0%	0%	0%	0%	-2%	-3%	-3%	-3%	-1%	0%	-1%	-1%	0%	2%	1%	0%	0%	0%	0%	0%	0%	0%
Aug	0%	0%	0%	0%	0%	0%	-1%	-4%	-4%	-3%	0%	-3%	-3%	-4%	-3%	-2%	-3%	-3%	-4%	-1%	0%	0%	0%	0%
Sep	0%	0%	0%	0%	0%	0%	-1%	-5%	-7%	-6%	-6%	-5%	-5%	-5%	-4%	-3%	-5%	-8%	-4%	0%	0%	0%	0%	0%
Oct	0%	0%	0%	0%	0%	0%	0%	-4%	-9%	-9%	-8%	-8%	-8%	-7%	-7%	-9%	-9%	-7%	-1%	0%	0%	0%	0%	0%
Nov	0%	0%	0%	0%	0%	0%	-1%	-9%	-13%	-12%	-11%	-9%	-11%	-13%	-12%	-11%	-4%	-1%	0%	0%	0%	0%	0%	0%
Dec	0%	0%	0%	0%	0%	0%	0%	-4%	-12%	-14%	-14%	-11%	-11%	-10%	-13%	-9%	-1%	0%	0%	0%	0%	0%	0%	0%

- 73% is level required to have difference of 5% or less in all hours (coincides with summer months)

Avg Worst Day vs Exceedance

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Jan	0%	0%	0%	0%	0%	0%	0%	-1%	-7%	-8%	-6%	-3%	-4%	-5%	-6%	-7%	-3%	0%	0%	0%	0%	0%	0%	0%
Feb	0%	0%	0%	0%	0%	0%	0%	-2%	-3%	-4%	-6%	-6%	-8%	-8%	-7%	-6%	-3%	-1%	0%	0%	0%	0%	0%	0%
Mar	0%	0%	0%	0%	0%	0%	-2%	-13%	-14%	-12%	-11%	-12%	-12%	-13%	-14%	-14%	-9%	-12%	-4%	0%	0%	0%	0%	0%
Apr	0%	0%	0%	0%	0%	0%	-3%	-13%	-15%	-16%	-16%	-17%	-17%	-18%	-18%	-19%	-17%	-13%	-7%	-1%	0%	0%	0%	0%
May	0%	0%	0%	0%	0%	0%	-3%	-9%	-11%	-12%	-12%	-9%	-13%	-13%	-13%	-12%	-13%	-11%	-6%	-2%	0%	0%	0%	0%
Jun	0%	0%	0%	0%	0%	0%	-2%	-3%	-5%	-4%	-4%	-3%	-3%	-2%	-2%	-3%	-3%	-3%	-3%	-1%	0%	0%	0%	0%
Jul	0%	0%	0%	0%	0%	0%	-1%	-1%	0%	0%	1%	2%	2%	2%	2%	5%	4%	4%	2%	1%	0%	0%	0%	0%
Aug	0%	0%	0%	0%	0%	0%	-1%	-1%	-1%	0%	3%	0%	0%	0%	2%	2%	2%	1%	-2%	-1%	0%	0%	0%	0%
Sep	0%	0%	0%	0%	0%	0%	0%	-2%	-4%	-3%	-1%	-3%	-2%	-1%	1%	1%	1%	-3%	-4%	0%	0%	0%	0%	0%
Oct	0%	0%	0%	0%	0%	0%	0%	-3%	-6%	-6%	-5%	-5%	-4%	-4%	-3%	-4%	-4%	-5%	-1%	0%	0%	0%	0%	0%
Nov	0%	0%	0%	0%	0%	0%	-1%	-6%	-9%	-7%	-6%	-5%	-8%	-8%	-7%	-8%	-4%	-1%	0%	0%	0%	0%	0%	0%
Dec	0%	0%	0%	0%	0%	0%	0%	-3%	-7%	-8%	-8%	-7%	-6%	-8%	-8%	-5%	-1%	0%	0%	0%	0%	0%	0%	0%

Level to perform analysis

Several options to perform solar and wind analysis:

- Aggregate "solar" and "wind"
- Aggregate subcategory: technology type, geography, or a combination of the two
- Individual resource level

Issues and benefits

- More granular levels create incentives to invest in best technology and maintenance
- Aggregate results will differ from sum of subcategories or individual resources, so exceedance % applied at each level may need to differ
- Easy to assign new resources without sufficient data to subcategory level; may need more involved method if counting is performed at individual resource level

Solar

- We've shown you aggregate "solar," as we don't have data for tracking v. fixed

Wind

- For wind, we had north and south of path 15 data, which we'll show you next
- Need input from the industry on desired level of disaggregation

Exceedance Analysis - Wind

- Tables below show the average wind generation on worst days (2015-2020) in terms of capacity factor for NP 15 (top) and SP 15 (bottom)
  - Results are consistent with findings in ED regional wind study (higher capacity factors in summer evening hours in NP 15).

Average Generation on Worst Days in NP15 Resources (2015-2020)

NP15 Avg	Hour Ending																							
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Jan	11%	11%	12%	13%	13%	13%	14%	14%	13%	10%	9%	9%	10%	12%	13%	13%	12%	13%	14%	16%	15%	13%	13%	13%
Feb	26%	28%	27%	27%	25%	24%	25%	26%	27%	27%	27%	27%	25%	23%	22%	21%	15%	16%	18%	20%	20%	21%	21%	21%
Mar	19%	17%	16%	17%	19%	16%	14%	14%	13%	14%	15%	14%	14%	17%	18%	19%	21%	23%	24%	25%	27%	28%	27%	26%
Apr	39%	38%	36%	35%	32%	28%	25%	23%	20%	18%	16%	14%	13%	13%	15%	17%	22%	26%	28%	32%	35%	38%	41%	45%
May	52%	51%	50%	48%	43%	41%	36%	31%	29%	27%	24%	20%	20%	20%	23%	30%	34%	39%	42%	47%	53%	55%	58%	58%
Jun	59%	59%	56%	52%	49%	45%	41%	35%	28%	23%	19%	16%	14%	15%	18%	26%	36%	43%	47%	51%	55%	58%	59%	62%
Jul	65%	64%	62%	59%	55%	51%	49%	43%	36%	29%	23%	19%	19%	21%	26%	34%	40%	46%	48%	52%	56%	59%	63%	66%
Aug	56%	56%	54%	51%	49%	44%	39%	35%	28%	23%	18%	17%	16%	16%	20%	24%	31%	36%	40%	46%	53%	58%	61%	61%
Sep	40%	38%	37%	34%	31%	29%	28%	26%	22%	18%	14%	12%	10%	10%	12%	16%	19%	24%	29%	36%	41%	45%	47%	48%
Oct	20%	21%	22%	20%	19%	18%	16%	14%	13%	12%	13%	13%	11%	12%	11%	11%	10%	11%	13%	16%	20%	22%	24%	25%
Nov	11%	10%	9%	7%	6%	5%	4%	4%	4%	4%	3%	3%	5%	5%	6%	6%	7%	8%	8%	8%	10%	12%	13%	15%
Dec	19%	18%	18%	17%	17%	18%	18%	17%	15%	15%	15%	15%	16%	15%	14%	12%	11%	11%	11%	11%	12%	12%	13%	14%

Average Generation on Worst Days in SP15 Resources (2015-2020)

SP15 Avg	Hour Ending																							
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Jan	15%	15%	14%	14%	15%	15%	15%	13%	13%	12%	12%	13%	14%	15%	16%	17%	17%	17%	16%	16%	16%	16%	17%	18%
Feb	19%	19%	19%	17%	16%	16%	15%	15%	15%	17%	19%	19%	21%	22%	22%	21%	19%	19%	18%	18%	17%	16%	16%	16%
Mar	18%	17%	16%	15%	13%	10%	10%	10%	10%	10%	11%	12%	11%	13%	15%	17%	17%	17%	17%	18%	19%	19%	18%	18%
Apr	28%	27%	26%	24%	21%	19%	16%	13%	11%	11%	10%	11%	12%	13%	16%	19%	22%	25%	28%	28%	29%	29%	29%	29%
May	40%	39%	37%	34%	30%	26%	22%	18%	13%	11%	9%	9%	10%	11%	14%	19%	25%	31%	33%	34%	36%	37%	37%	36%
Jun	31%	29%	27%	25%	22%	19%	16%	12%	9%	8%	7%	7%	9%	11%	15%	19%	24%	27%	30%	32%	35%	36%	35%	34%
Jul	34%	33%	31%	28%	25%	21%	17%	13%	9%	7%	6%	6%	8%	10%	14%	19%	25%	29%	33%	36%	36%	37%	38%	35%
Aug	31%	29%	27%	24%	21%	18%	14%	11%	8%	6%	6%	7%	8%	10%	13%	18%	22%	26%	29%	31%	33%	33%	32%	32%
Sep	14%	14%	13%	12%	10%	8%	7%	6%	5%	5%	5%	6%	8%	10%	11%	14%	16%	17%	19%	21%	22%	22%	21%	21%
Oct	7%	7%	7%	7%	6%	6%	5%	5%	4%	4%	5%	6%	7%	7%	8%	8%	9%	10%	10%	11%	11%	11%	12%	12%
Nov	9%	8%	7%	7%	6%	6%	5%	5%	5%	6%	6%	7%	9%	9%	9%	10%	10%	10%	10%	10%	10%	10%	10%	9%
Dec	16%	15%	15%	15%	14%	14%	13%	13%	14%	14%	15%	17%	17%	18%	18%	18%	17%	17%	16%	15%	16%	15%	15%	13%

Note that data does not adjust for curtailments

Exceedance Analysis – Wind SP15

- 80% level required to have no positive values (2 decimal places)

SP15 Avg — Average Worst Days Vs. Exceedance

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Jan	-13%	-13%	-13%	-13%	-13%	-14%	-14%	-12%	-12%	-11%	-11%	-12%	-13%	-14%	-15%	-15%	-16%	-15%	-14%	-15%	-15%	-14%	-16%	-16%
Feb	-17%	-17%	-16%	-14%	-13%	-13%	-13%	-13%	-13%	-16%	-17%	-17%	-19%	-20%	-19%	-18%	-17%	-16%	-15%	-15%	-14%	-13%	-14%	-14%
Mar	-12%	-12%	-10%	-10%	-8%	-7%	-6%	-7%	-8%	-8%	-9%	-9%	-8%	-9%	-12%	-14%	-12%	-12%	-12%	-12%	-13%	-12%	-12%	-12%
Apr	-13%	-13%	-12%	-11%	-11%	-11%	-9%	-8%	-7%	-7%	-6%	-7%	-7%	-7%	-10%	-11%	-12%	-10%	-11%	-10%	-9%	-9%	-12%	-13%
May	-14%	-15%	-14%	-11%	-12%	-12%	-10%	-10%	-8%	-6%	-5%	-5%	-5%	-5%	-7%	-6%	-5%	-6%	-6%	-6%	-7%	-8%	-9%	-9%
Jun	0%	-2%	-1%	-1%	-1%	-2%	-2%	-2%	-3%	-3%	-3%	-2%	-3%	-5%	-6%	-6%	-6%	-5%	-3%	-2%	-2%	-3%	-3%	-3%
Jul	-8%	-9%	-8%	-9%	-9%	-9%	-7%	-5%	-4%	-4%	-3%	-3%	-4%	-5%	-7%	-8%	-8%	-8%	-9%	-10%	-10%	-8%	-11%	-10%
Aug	-8%	-9%	-9%	-8%	-8%	-7%	-6%	-6%	-4%	-4%	-4%	-4%	-4%	-6%	-7%	-8%	-9%	-9%	-8%	-8%	-7%	-7%	-8%	-9%
Sep	-7%	-8%	-8%	-7%	-6%	-5%	-4%	-3%	-3%	-3%	-3%	-4%	-5%	-5%	-7%	-10%	-11%	-10%	-10%	-12%	-13%	-13%	-14%	-14%
Oct	-4%	-4%	-4%	-3%	-3%	-3%	-3%	-3%	-3%	-3%	-3%	-4%	-4%	-4%	-5%	-5%	-6%	-7%	-6%	-7%	-7%	-7%	-8%	-9%
Nov	-7%	-6%	-6%	-5%	-5%	-4%	-3%	-3%	-4%	-4%	-5%	-5%	-7%	-7%	-7%	-8%	-9%	-8%	-7%	-7%	-7%	-8%	-8%	-7%
Dec	-13%	-12%	-13%	-12%	-11%	-11%	-11%	-11%	-12%	-12%	-14%	-14%	-15%	-16%	-16%	-16%	-15%	-15%	-13%	-12%	-13%	-12%	-12%	-11%

- 78% level required to have difference of 2% or less in all hours

SP15 Avg — Average Worst Days Vs. Exceedance

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Jan	-13%	-13%	-12%	-13%	-13%	-14%	-13%	-12%	-11%	-11%	-10%	-11%	-13%	-13%	-14%	-15%	-16%	-15%	-14%	-14%	-14%	-14%	-15%	-16%
Feb	-16%	-16%	-16%	-14%	-13%	-13%	-13%	-13%	-13%	-15%	-17%	-17%	-19%	-19%	-19%	-17%	-16%	-16%	-15%	-15%	-13%	-13%	-13%	-13%
Mar	-11%	-11%	-9%	-10%	-8%	-5%	-6%	-7%	-7%	-8%	-9%	-9%	-8%	-9%	-12%	-13%	-11%	-11%	-10%	-10%	-11%	-10%	-11%	-12%
Apr	-12%	-13%	-10%	-10%	-9%	-10%	-8%	-8%	-6%	-6%	-6%	-6%	-6%	-6%	-9%	-8%	-10%	-10%	-8%	-8%	-6%	-6%	-10%	-11%
May	-13%	-13%	-13%	-10%	-11%	-12%	-10%	-9%	-8%	-5%	-4%	-4%	-4%	-5%	-6%	-4%	-3%	-5%	-4%	-6%	-6%	-6%	-8%	-9%
Jun	2%	2%	0%	0%	1%	0%	-1%	-1%	-2%	-3%	-3%	-2%	-2%	-5%	-6%	-5%	-5%	-4%	-2%	0%	-1%	-2%	-2%	-1%
Jul	-8%	-9%	-7%	-8%	-8%	-7%	-6%	-5%	-4%	-4%	-3%	-3%	-4%	-5%	-6%	-7%	-8%	-7%	-7%	-9%	-7%	-7%	-10%	-9%
Aug	-7%	-7%	-8%	-7%	-7%	-6%	-6%	-5%	-4%	-4%	-3%	-4%	-4%	-6%	-7%	-8%	-9%	-8%	-7%	-6%	-6%	-6%	-7%	-8%
Sep	-7%	-7%	-8%	-7%	-6%	-5%	-4%	-3%	-3%	-3%	-3%	-3%	-4%	-5%	-7%	-9%	-10%	-10%	-9%	-11%	-12%	-12%	-13%	-12%
Oct	-4%	-4%	-4%	-3%	-3%	-3%	-3%	-3%	-2%	-3%	-3%	-4%	-4%	-4%	-5%	-5%	-6%	-7%	-6%	-7%	-7%	-7%	-8%	-9%
Nov	-7%	-6%	-5%	-5%	-5%	-4%	-3%	-3%	-3%	-4%	-4%	-5%	-7%	-7%	-7%	-8%	-8%	-8%	-7%	-7%	-7%	-8%	-8%	-7%
Dec	-13%	-12%	-12%	-12%	-11%	-11%	-11%	-11%	-12%	-12%	-13%	-14%	-15%	-16%	-16%	-16%	-15%	-14%	-13%	-12%	-13%	-12%	-12%	-11%

- 72% level required to have difference of 5% or less in all hours

SP15 Avg — Average Worst Days Vs. Exceedance

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Jan	-12%	-12%	-12%	-12%	-12%	-13%	-12%	-11%	-10%	-10%	-10%	-11%	-12%	-13%	-14%	-15%	-15%	-14%	-13%	-14%	-14%	-13%	-14%	-15%
Feb	-15%	-15%	-15%	-13%	-12%	-12%	-12%	-12%	-12%	-15%	-16%	-16%	-18%	-18%	-18%	-17%	-15%	-13%	-13%	-13%	-12%	-11%	-11%	-12%
Mar	-8%	-8%	-7%	-8%	-6%	-3%	-4%	-4%	-6%	-7%	-7%	-7%	-7%	-7%	-10%	-10%	-9%	-5%	-5%	-7%	-7%	-7%	-8%	-9%
Apr	-5%	-5%	-4%	-6%	-5%	-5%	-6%	-5%	-5%	-4%	-4%	-5%	-4%	-5%	-4%	-5%	-3%	-3%	-3%	-3%	-2%	-4%	-5%	-5%
May	-9%	-10%	-8%	-8%	-7%	-6%	-6%	-6%	-5%	-3%	-3%	-3%	-3%	-3%	-4%	-1%	0%	1%	-2%	-2%	-4%	-4%	-5%	-4%
Jun	4%	5%	4%	4%	3%	2%	2%	1%	0%	-2%	-2%	-2%	-2%	-3%	-3%	-2%	-1%	2%	3%	4%	1%	1%	1%	2%
Jul	-4%	-4%	-4%	-5%	-5%	-4%	-5%	-4%	-3%	-3%	-2%	-2%	-3%	-3%	-5%	-4%	-5%	-4%	-4%	-6%	-5%	-5%	-6%	-4%
Aug	-4%	-4%	-5%	-4%	-6%	-5%	-5%	-3%	-3%	-3%	-3%	-3%	-3%	-4%	-5%	-6%	-5%	-5%	-5%	-5%	-4%	-3%	-2%	-3%
Sep	-4%	-5%	-5%	-6%	-5%	-4%	-3%	-2%	-2%	-2%	-2%	-3%	-4%	-5%	-6%	-9%	-9%	-7%	-6%	-6%	-7%	-6%	-8%	-8%
Oct	-2%	-3%	-3%	-2%	-2%	-2%	-2%	-2%	-2%	-2%	-3%	-3%	-4%	-3%	-4%	-5%	-5%	-5%	-5%	-5%	-5%	-5%	-6%	-7%
Nov	-6%	-6%	-5%	-5%	-4%	-3%	-3%	-3%	-3%	-3%	-4%	-4%	-6%	-6%	-7%	-7%	-8%	-7%	-7%	-6%	-6%	-7%	-8%	-7%
Dec	-12%	-11%	-12%	-11%	-10%	-10%	-10%	-10%	-11%	-12%	-13%	-14%	-14%	-16%	-15%	-15%	-15%	-14%	-12%	-11%	-12%	-11%	-11%	-10%

Exceedance Analysis – Wind NP15

- 78% level required to have no positive values (2 decimal places)

NP15 Avg — Average Worst Days Vs. Exceedance

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Jan	-10%	-10%	-11%	-12%	-12%	-13%	-13%	-13%	-12%	-10%	-9%	-9%	-9%	-12%	-13%	-13%	-12%	-13%	-14%	-16%	-14%	-13%	-13%	-12%
Feb	-23%	-26%	-25%	-25%	-23%	-21%	-22%	-23%	-25%	-26%	-26%	-25%	-24%	-22%	-22%	-20%	-14%	-15%	-17%	-18%	-18%	-18%	-19%	-18%
Mar	-14%	-12%	-13%	-14%	-16%	-14%	-13%	-13%	-12%	-13%	-14%	-13%	-13%	-16%	-17%	-17%	-20%	-22%	-22%	-21%	-24%	-24%	-22%	-21%
Apr	-21%	-22%	-23%	-23%	-21%	-19%	-18%	-17%	-15%	-14%	-12%	-12%	-10%	-11%	-12%	-13%	-17%	-19%	-17%	-19%	-20%	-21%	-24%	-28%
May	-18%	-17%	-18%	-19%	-19%	-18%	-16%	-16%	-16%	-17%	-16%	-13%	-14%	-13%	-14%	-16%	-14%	-16%	-13%	-17%	-18%	-19%	-20%	-22%
Jun	-15%	-13%	-14%	-15%	-14%	-12%	-14%	-17%	-15%	-11%	-12%	-11%	-9%	-9%	-11%	-15%	-17%	-12%	-11%	-14%	-16%	-19%	-19%	-21%
Jul	-5%	-4%	-6%	-8%	-7%	-8%	-8%	-10%	-10%	-8%	-10%	-9%	-10%	-10%	-12%	-13%	-8%	-5%	-4%	-6%	-2%	-5%	-4%	-5%
Aug	-2%	-3%	-3%	-6%	-6%	-8%	-8%	-6%	-7%	-8%	-8%	-10%	-9%	-9%	-11%	-11%	-11%	-5%	-6%	0%	-2%	-2%	-7%	-6%
Sep	-19%	-17%	-18%	-16%	-17%	-19%	-18%	-19%	-17%	-14%	-12%	-10%	-9%	-8%	-10%	-13%	-14%	-16%	-20%	-21%	-24%	-27%	-30%	-29%
Oct	-12%	-13%	-16%	-16%	-15%	-14%	-13%	-11%	-11%	-10%	-12%	-12%	-11%	-11%	-11%	-10%	-10%	-10%	-11%	-13%	-15%	-17%	-18%	-18%
Nov	-10%	-9%	-8%	-6%	-6%	-5%	-3%	-3%	-3%	-3%	-3%	-3%	-5%	-5%	-6%	-6%	-7%	-8%	-8%	-8%	-9%	-11%	-13%	-14%
Dec	-18%	-17%	-17%	-16%	-16%	-17%	-17%	-15%	-14%	-14%	-14%	-14%	-15%	-15%	-13%	-12%	-11%	-11%	-10%	-11%	-11%	-11%	-12%	-12%

- 76% level required to have difference of 2% or less in all hours

NP15 Avg — Average Worst Days Vs. Exceedance

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Jan	-10%	-10%	-11%	-12%	-12%	-12%	-12%	-13%	-12%	-10%	-8%	-9%	-9%	-11%	-13%	-13%	-12%	-13%	-14%	-16%	-14%	-13%	-13%	-12%
Feb	-23%	-26%	-25%	-25%	-23%	-21%	-22%	-22%	-24%	-25%	-25%	-25%	-23%	-21%	-22%	-20%	-14%	-15%	-16%	-18%	-18%	-17%	-18%	-18%
Mar	-13%	-12%	-13%	-13%	-16%	-14%	-13%	-12%	-12%	-12%	-14%	-13%	-13%	-16%	-17%	-17%	-20%	-21%	-22%	-21%	-23%	-23%	-22%	-20%
Apr	-20%	-21%	-22%	-21%	-20%	-18%	-17%	-16%	-14%	-14%	-12%	-11%	-10%	-10%	-12%	-13%	-15%	-18%	-16%	-18%	-19%	-20%	-23%	-27%
May	-17%	-15%	-16%	-18%	-16%	-16%	-14%	-14%	-16%	-16%	-15%	-13%	-13%	-13%	-13%	-14%	-11%	-11%	-10%	-16%	-17%	-18%	-19%	-21%
Jun	-13%	-11%	-12%	-13%	-11%	-9%	-12%	-13%	-13%	-10%	-10%	-10%	-9%	-8%	-11%	-12%	-15%	-10%	-7%	-13%	-14%	-15%	-17%	-18%
Jul	-4%	-4%	-5%	-8%	-6%	-6%	-7%	-8%	-10%	-8%	-8%	-8%	-10%	-9%	-11%	-11%	-6%	-4%	-3%	-4%	-1%	-3%	-3%	-4%
Aug	0%	0%	-2%	-4%	-5%	-4%	-4%	-5%	-6%	-6%	-7%	-9%	-8%	-8%	-10%	-7%	-6%	-4%	-2%	0%	0%	-1%	-4%	-5%
Sep	-18%	-16%	-16%	-15%	-14%	-17%	-17%	-19%	-17%	-13%	-12%	-10%	-9%	-8%	-10%	-13%	-13%	-15%	-17%	-20%	-22%	-26%	-28%	-27%
Oct	-12%	-13%	-15%	-15%	-15%	-14%	-13%	-11%	-11%	-10%	-12%	-11%	-11%	-11%	-11%	-10%	-10%	-10%	-11%	-13%	-15%	-17%	-18%	-17%
Nov	-10%	-9%	-8%	-6%	-5%	-5%	-3%	-3%	-3%	-3%	-3%	-3%	-5%	-5%	-6%	-6%	-7%	-8%	-8%	-8%	-9%	-11%	-12%	-14%
Dec	-18%	-17%	-17%	-16%	-16%	-16%	-17%	-15%	-14%	-14%	-14%	-14%	-15%	-15%	-13%	-12%	-11%	-10%	-10%	-10%	-11%	-11%	-11%	-12%

- 74% level required to have difference of 5% or less in all hours

NP15 Avg — Average Worst Days Vs. Exceedance

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Jan	-10%	-10%	-11%	-12%	-12%	-12%	-12%	-12%	-12%	-9%	-8%	-9%	-9%	-11%	-13%	-13%	-12%	-13%	-13%	-16%	-14%	-13%	-12%	-12%
Feb	-22%	-25%	-24%	-24%	-22%	-21%	-22%	-22%	-24%	-25%	-25%	-25%	-23%	-21%	-22%	-19%	-14%	-14%	-16%	-16%	-17%	-17%	-17%	-18%
Mar	-13%	-12%	-12%	-13%	-15%	-14%	-12%	-12%	-11%	-12%	-14%	-13%	-12%	-15%	-17%	-17%	-20%	-21%	-21%	-21%	-23%	-21%	-21%	-19%
Apr	-19%	-20%	-19%	-20%	-19%	-18%	-16%	-16%	-14%	-13%	-12%	-10%	-9%	-10%	-11%	-12%	-15%	-17%	-16%	-17%	-18%	-18%	-20%	-25%
May	-15%	-12%	-14%	-14%	-16%	-16%	-14%	-13%	-15%	-15%	-15%	-11%	-12%	-12%	-12%	-13%	-10%	-9%	-8%	-13%	-16%	-16%	-16%	-19%
Jun	-13%	-9%	-10%	-11%	-8%	-8%	-9%	-11%	-11%	-8%	-9%	-9%	-8%	-8%	-10%	-11%	-11%	-7%	-6%	-11%	-13%	-13%	-15%	-16%
Jul	-2%	-3%	-4%	-6%	-3%	-3%	-5%	-7%	-5%	-7%	-7%	-8%	-8%	-8%	-10%	-9%	-5%	-3%	-1%	-1%	0%	0%	-2%	-3%
Aug	2%	4%	0%	-3%	-3%	0%	-1%	-5%	-4%	-5%	-6%	-8%	-7%	-7%	-9%	-5%	-4%	-2%	0%	1%	2%	-1%	-2%	-3%
Sep	-16%	-13%	-14%	-14%	-14%	-15%	-16%	-18%	-16%	-13%	-11%	-10%	-8%	-8%	-9%	-12%	-13%	-14%	-16%	-19%	-21%	-23%	-26%	-26%
Oct	-11%	-12%	-15%	-15%	-14%	-14%	-12%	-11%	-10%	-10%	-12%	-11%	-11%	-11%	-10%	-10%	-10%	-9%	-10%	-12%	-14%	-16%	-16%	-16%
Nov	-10%	-9%	-7%	-6%	-5%	-4%	-3%	-3%	-3%	-3%	-3%	-2%	-5%	-5%	-6%	-6%	-7%	-7%	-8%	-8%	-9%	-11%	-12%	-14%
Dec	-18%	-16%	-16%	-15%	-16%	-16%	-17%	-15%	-14%	-14%	-14%	-14%	-15%	-14%	-13%	-12%	-10%	-10%	-10%	-10%	-10%	-10%	-11%	-12%

Resource Counting Step-by-Step

PG&E Steps
Steps 1-3: develop worst load day profiles
Steps 4-6: compare to exceedance data to identify appropriate exceedance level
Resource Counting Output = Hourly exceedance value

← Some phase 1 proposals stopped after developing worst load day profiles

PG&E Proposal:

Pros: Flexible and adjustable, allowing for effective calibration within PRM process

Cons: Additional steps involved

Key Issues / Questions

- Process for selecting exceedance level is only first step; final level should be determined as part of the PRM analysis

- Production v. Forecast Data
  - Production captures actual generation best, but captures congestion and curtailments
  - CAISO forecast would eliminate congestion and curtailments, but variations can occur between forecast and actual

- How many years of data to use?
  - Many options between 3 – 10 years
  - This analysis used 6 years; CEC stack analysis used 8 years
  - Hydro uses 10 years, but no new hydro units are being built, so all hydro resources have 10+ years