Resource Counting: Recap for Solar, Wind, Hybrids

August 23, 2022

Together, Building
a Better California

PG&E Proposal: Solar and Wind

Given data and analysis presented to date:

- **Exceedance-based approach:** Selected based on analysis of solar and wind performance on "high-load days" in summer months
  - Alternative methods have small datasets
  - Alternative methods haven't demonstrated that high-load days in non-summer months presents greatest reliability risk in those months
- **Exceedance level:** 70% across all months and hours
  - High enough to eliminate much of the discrepancy between the exceedance level and high-load days profile
  - Conservative enough to address concerns with performance within months and hours
  - Calibration could still be performed as part of PRM-setting process
- **Data**: Five years of CAISO production data, adjusted for economic curtailments
  - Modeled data from IRP has profiles that are fairly different from CAISO data
- **Aggregation level**: Technology type and geography (e.g. fixed v. tracking and NP15 / SP 15)
  - Data is available to do this level of aggregation
  - Presents a compromise between more general categories and resource-specific

Exceedance-Based Approach: Background

Review solar and wind performance under stressed grid conditions

- PG&E's approach looks at the top 5 load days each month (30 datapoints for each hour in each month over a 6-year dataset)

Process

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

Exceedance-Based Approach: Example Steps

Steps 1-3: Average solar generation on high-load 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 high-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 high-load day analysis
- **Positive values (red)** indicates that **more solar is counted** in that exceedance level than expected from the high-load day analysis

Exceedance-Based Approach: Comparing Competing Proposals

PG&E Steps
Steps 1-3: develop high-load day profiles
Steps 4-6: compare to exceedance data to identify appropriate exceedance level
Resource Counting Output = Hourly exceedance value (12x24)

Other Approaches:

CalWEA, NRDC Worst-Day, NRDC LOLE-Informed

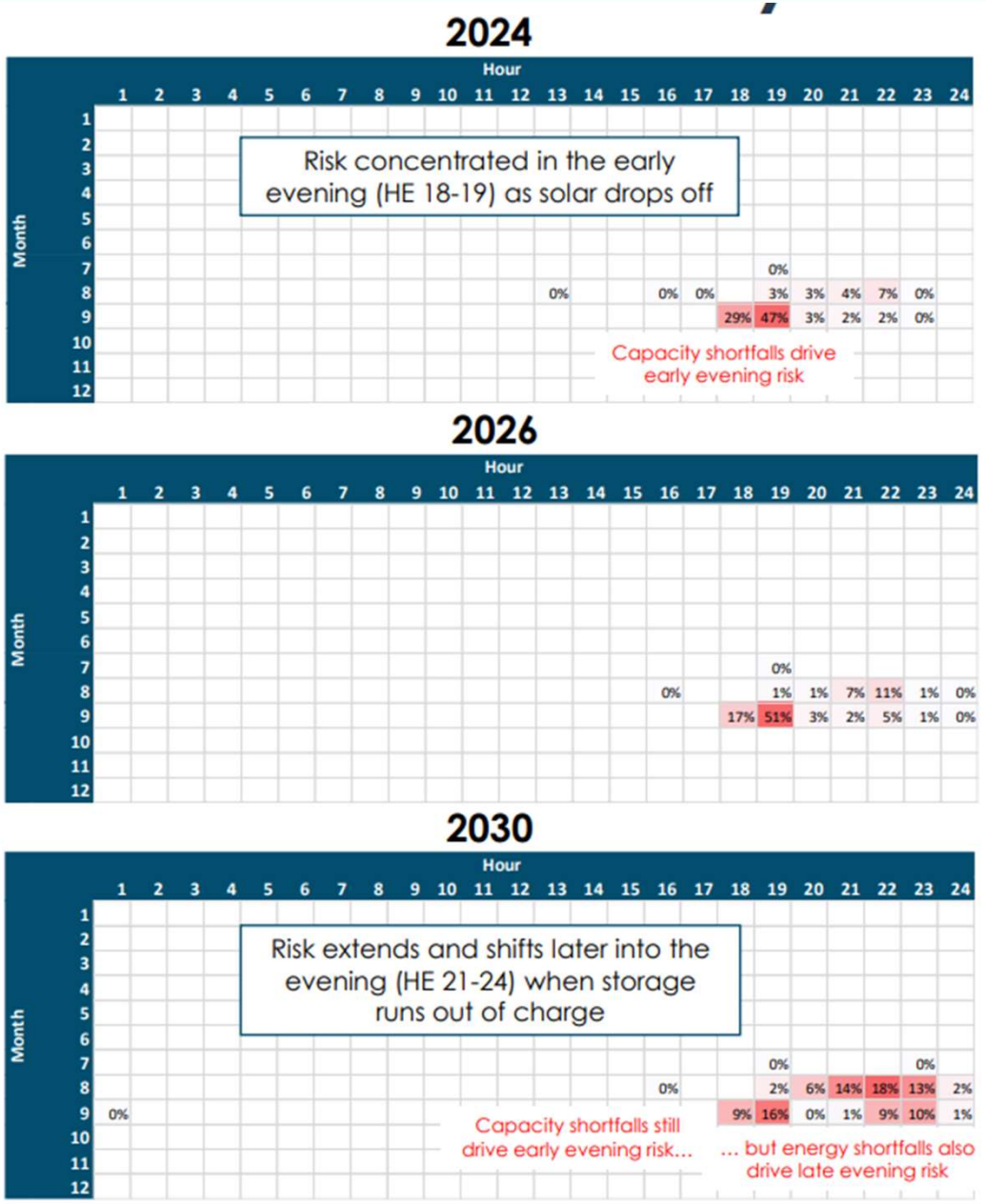
- Stop after developing high-load day profiles

Exceedance-Based Approach: Problems w/ Using High-Load Day Profiles

- **Small Dataset**: Results in a small dataset that would lead to greater profile changes when updated
  - Five highest load days across five years of data results in 25 data points for each hour
  - Exceedance has 150 data points
  - Unusual performance in any given year will have a greater impact on a high-load day profile while an exceedance-based one will be much more stable
    - A more stable profile creates greater certainty for all parties: developers, resources owners, LSEs
- **Unclear Reliability Risk in Non-Summer Months**:
  - High-load days are the clear reliability risk in summer months
  - Not clear this is the case in other months (e.g. cloudy day risk)
  - Charging sufficiency will increasingly be important

Exceedance Level:
Hours of Greatest Concern – LOLE Hours

- Previously we looked at summer late afternoon / evening hours to identify hours of greatest concern
- We reviewed IRP LOLE study results to focus on critical reliability hours
- Graphs at right are loss of load hours from IRP LOLE study
- September HE18 and 19 are most critical now, but these risks shift to later hours in August and September by 2030



Source: IRP MAG Webinar (7/19/22), ED, slide 71

Exceedance Level:
LOLE Hours and Solar / Wind Performance

70% strikes a reasonable balance between solar and wind performance on high load days and LOLE hours

70% Exceedance - High-load day profile for Solar

	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%	-6%	-6%	-5%	-2%	-2%	-3%	-4%	-6%	-2%	0%	0%	0%	0%	0%	0%	0%
Feb	0%	0%	0%	0%	0%	0%	0%	-1%	-1%	-2%	-4%	-5%	-4%	-6%	-5%	-3%	-2%	-1%	0%	0%	0%	0%	0%	0%
Mar	0%	0%	0%	0%	0%	0%	-2%	-13%	-14%	-11%	-9%	-11%	-10%	-11%	-13%	-11%	-6%	-11%	-3%	0%	0%	0%	0%	0%
Apr	0%	0%	0%	0%	0%	0%	-3%	-12%	-14%	-15%	-15%	-15%	-16%	-16%	-15%	-17%	-14%	-11%	-7%	-1%	0%	0%	0%	0%
May	0%	0%	0%	0%	0%	0%	-3%	-7%	-10%	-11%	-10%	-8%	-12%	-11%	-12%	-11%	-12%	-8%	-6%	-1%	0%	0%	0%	0%
Jun	0%	0%	0%	0%	0%	0%	-2%	-3%	-4%	-4%	-3%	-2%	-2%	-1%	-1%	-1%	-2%	-1%	-2%	-1%	0%	0%	0%	0%
Jul	0%	0%	0%	0%	0%	0%	0%	0%	1%	1%	2%	2%	2%	2%	3%	6%	5%	5%	3%	1%	0%	0%	0%	0%
Aug	0%	0%	0%	0%	0%	0%	0%	-1%	0%	0%	4%	0%	0%	1%	3%	4%	3%	2%	-1%	-1%	0%	0%	0%	0%
Sep	0%	0%	0%	0%	0%	0%	0%	-2%	-3%	-2%	-1%	-1%	-1%	0%	2%	3%	1%	-2%	-4%	0%	0%	0%	0%	0%
Oct	0%	0%	0%	0%	0%	0%	0%	-3%	-5%	-5%	-5%	-3%	-3%	-2%	-2%	-3%	-3%	-4%	-1%	0%	0%	0%	0%	0%
Nov	0%	0%	0%	0%	0%	0%	-1%	-5%	-7%	-6%	-5%	-4%	-6%	-6%	-6%	-7%	-3%	-1%	0%	0%	0%	0%	0%	0%
Dec	0%	0%	0%	0%	0%	0%	0%	-2%	-7%	-7%	-6%	-6%	-5%	-6%	-7%	-5%	-1%	0%	0%	0%	0%	0%	0%	0%

70% Exceedance - High-load day profile for SP15 Wind

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

70% Exceedance - High-load day profile for NP15 Wind

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

Exceedance Level: Other Considerations

Distribution across the month and hours:

- Distribution of high-load days across the month
  - Early September has better solar production than late September
  - Late August has worse solar production than early August
  - Assuming average production across the month could leave the system short early or late in the month

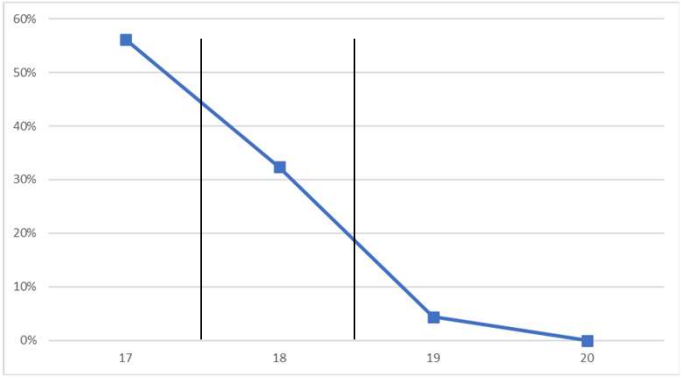
- Distribution of production across hours
  - Solar production falls off quickly in evening hours
  - Hourly production is total production for that hour
  - Large decreases in production within an hour in the evening could result in insufficient supply at the end of the hour

- Can this be resolved?
  - More granular accounting (no one has the appetite for sub-hourly or sub-monthly)
  - Likely best addressed through more conservative counting

High-load day observations distribution across August and September

Bins	August	September
Days 1-10	8	19
Days 11-20	13	4
Days 21-31	9	7

70% solar exceedance profile for September HE17-20



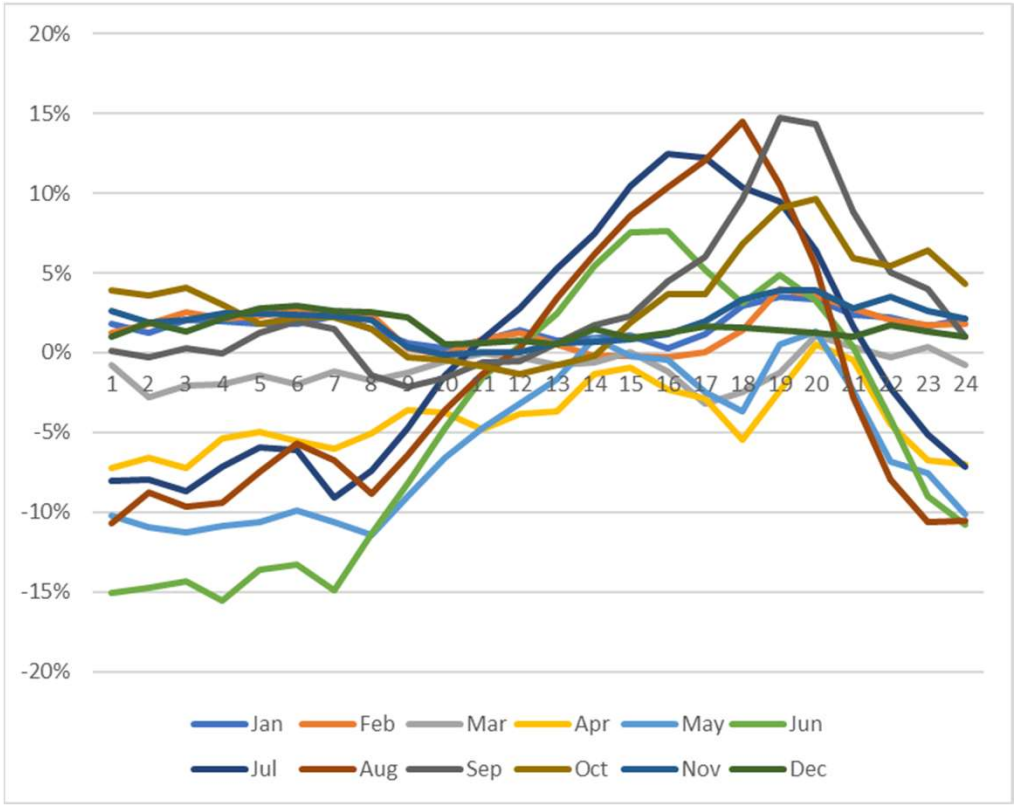
PRM Calibration:

- Key objective in selecting a counting methodology is to ensure the resource isn't leaning on the system or has an unduly conservative approach relative to other resource types
- Higher or lower exceedance levels could be tested in PRM-setting process to test 70% exceedance value relative to Pcap or ELCC value

Data: Summary

- Years of Data:
  - Five years
- CAISO OASIS production data or modeled:
  - CAISO Production
  - Modeled data from IRP has profiles that are fairly different from CAISO data; if modeled data is used, a more in-depth analysis of the differences between modeled and production data should be undertaken
- Adjustments:
  - Adjusted for economic curtailments, if possible
  - Profiles shouldn't be penalized for curtailed production due to low prices

Difference in capacity factors between IRP wind profiles and 70% exceedance wind profiles



Aggregation Level: Summary

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

Proposal:

- Aggregate subcategories:
  - Solar:
    - Tracking
    - Fixed
  - Wind:
    - NP 15
    - SP 15
    - Out of state (need input from industry on number of categories)

Hybrid Resource Counting

PG&E's proposal offers the most administratively straightforward approach to accurately count hybrid capacity contributions for resources with charging restrictions

PG&E Proposal for Hybrid Resources with Charging Restrictions

- Retain existing rules and methodology but apply new counting methodology, e.g. exceedance, to determine charging sufficiency and to count excess production
- Methodology used to determine sufficient charging capacity accounts for losses
- All renewable capacity is used for charging, even if all of it isn't deliverable
  - Limited or no deliverability for renewable component of resource with charging restrictions is not problematic (excess shouldn't be counted for RA though)

CESA Proposal to Use Energy-Only Counting for Standalone Storage

- Violates important RA program rules
- Fails to account for material differences between hybrid and standalone resources

Inflation Reduction Act Signed Into Law

- Expands ITC eligibility to storage resources, may limit the number of resources subject to charging restrictions
- How many resources will still be subject to charging restrictions?