The Public ADVOCATES OFFICE

4-Season Wind Exceedance Proposal

Resource Adequacy Reform Workshop 10

October 6, 2022

Agenda

1. Motivation
2. Proposal
3. Two Examples
4. Comparisons
5. Ratepayer benefits

Motivation

1. Correlation is very low between wind and load—another step needed to justify selecting an exceedance value
2. 70th percentile for wind is very conservative, constrained almost entirely by evening capacity in August

Proposal

1. Use four seasons (quarters) to set exceedance values
2. Set the exceedance value by minimizing the absolute value of the sum of the difference between the Average of the Top 5 Worst Days and the percentile's Capacity Factor (CF)

Review

Average annual capacity factors

NP15: 15.8% SP15: 11.2%

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
1 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%
2 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%
3 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%
4 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%
5 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%
6 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%
7 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%
8 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%
9 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%
10 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%
11 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%
12 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 Worst Days Vs. Exceedance

Exceedance Value	NP15 Avg	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	Sum	Abs(Sum)	Max
70%	1 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%			
	2 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%	-1097%	1097%	-8%
	3 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%			
	4 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%			
	5 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%	-748%	748%	-2%
	6 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%			
	7 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%			
	8 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%	-332%	450%	9%
	9 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%			
	10 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%			
	11 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%	-724%	724%	-2%
	12 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%			

Example 1:
4 seasons NP15

Average annual capacity factor
NP15: 25.4% (+9.6%)

Four Seasons

Average Worst Days Vs. Exceedance

Exceedance Value		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	Sum	Abs(Sum)	Max
	1 Jan	1%	0%	-3%	-4%	-4%	-3%	-3%	-2%	-2%	-2%	-2%	-2%	-3%	-5%	-7%	-6%	-5%	-5%	-5%	-7%	-5%	-3%	-2%	-1%			
32%	2 Feb	1%	-1%	-3%	-8%	-5%	-5%	-6%	-6%	-8%	-8%	-10%	-9%	-9%	-2%	-1%	-1%	2%	-3%	-3%	0%	0%	2%	3%	3%	-85%	249%	8%
	3 Mar	7%	8%	8%	6%	2%	2%	4%	5%	3%	1%	1%	2%	2%	2%	2%	3%	2%	4%	3%	1%	0%	-1%	-1%	1%			
	4 Apr	-8%	-8%	-8%	-10%	-11%	-8%	-8%	-7%	-9%	-6%	-5%	-5%	-4%	-3%	-5%	-5%	-2%	-3%	-7%	-7%	-4%	-8%	-8%	-14%			
57%	5 May	2%	0%	-1%	-1%	-2%	-4%	-4%	-2%	-2%	-4%	-5%	-5%	-3%	1%	-1%	0%	5%	6%	4%	3%	-3%	-1%	-4%	-5%	-100%	316%	7%
	6 Jun	4%	4%	4%	6%	5%	3%	1%	5%	2%	2%	2%	2%	2%	2%	3%	5%	7%	7%	5%	4%	3%	1%	3%	2%			
	7 Jul	4%	2%	4%	4%	6%	6%	4%	3%	1%	1%	0%	0%	-1%	-2%	-1%	-2%	3%	4%	5%	7%	7%	7%	5%	4%			
62%	8 Aug	15%	14%	11%	10%	10%	9%	8%	7%	4%	2%	0%	0%	-2%	1%	1%	4%	7%	8%	8%	9%	9%	9%	9%	9%	67%	418%	15%
	9 Sep	0%	-1%	-3%	-3%	-6%	-6%	-8%	-8%	-7%	-6%	-6%	-6%	-5%	-5%	-6%	-7%	-7%	-10%	-8%	-9%	-10%	-11%	-15%	-12%			
	10 Oct	8%	7%	5%	3%	1%	-1%	-1%	0%	-1%	-1%	0%	-1%	-1%	-1%	0%	1%	3%	6%	7%	8%	9%	9%	5%	5%			
38%	11 Nov	1%	2%	4%	3%	3%	4%	4%	4%	2%	2%	1%	2%	-1%	-1%	-1%	-1%	-1%	-2%	-2%	-1%	-1%	-1%	-2%	-3%	-31%	251%	9%
	12 Dec	-6%	-5%	-7%	-6%	-6%	-7%	-8%	-6%	-6%	-7%	-6%	-8%	-9%	-8%	-7%	-6%	-4%	-3%	-2%	-1%	-1%	0%	0%	0%			
																		MIN	-15.3%	MAX	14.7%	AVG	-0.52%	SD	0.0526			

Annual

NP15 Avg

Average Worst Days Vs. Exceedance

Exceedance Value		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	Sum	Abs(Sum)	Max
70%	1 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%			
	2 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%	-1097%	1097%	-8%
	3 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%			
	4 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%			
	5 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%	-748%	748%	-2%
	6 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%			
	7 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%			
	8 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%	-332%	450%	9%
	9 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%			
	10 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%			
	11 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%	-724%	724%	-2%
	12 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%			
																		MIN	-24.1%	MAX	8.8%	AVG	-10.1%	SD	0.0623			

Example 1:
4 seasons SP15

Average annual capacity factor
SP15: 17.1% (+5.9%)

Four Seasons

Average Worst Days Vs. Exceedance

Exceedance Value		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	Sum	Abs(Sum)	Max
	1 Jan	-7%	-7%	-5%	-5%	-6%	-7%	-7%	-6%	-5%	-5%	-4%	-4%	-5%	-6%	-6%	-7%	-7%	-6%	-6%	-7%	-7%	-9%	-10%	-10%			
42%	2 Feb	-3%	-3%	-3%	-2%	-1%	-2%	-3%	-2%	-5%	-7%	-7%	-5%	-6%	-5%	-3%	-3%	-2%	-2%	1%	1%	2%	2%	2%	-2%	43%	486%	15%
	3 Mar	11%	10%	11%	11%	13%	13%	13%	10%	9%	7%	6%	5%	5%	8%	10%	12%	12%	15%	14%	15%	13%	12%	11%	11%			
	4 Apr	0%	1%	0%	0%	1%	-1%	0%	0%	-1%	0%	0%	0%	0%	-1%	0%	1%	2%	4%	3%	1%	1%	-1%	-1%	-1%			
66%	5 May	-6%	-6%	-4%	-4%	-2%	-3%	-2%	-3%	-3%	-2%	-2%	-1%	0%	-1%	0%	1%	4%	3%	2%	1%	-1%	-1%	-1%	-1%	66%	170%	8%
	6 Jun	7%	7%	8%	7%	6%	6%	5%	4%	3%	1%	0%	0%	0%	-1%	-2%	0%	3%	5%	8%	6%	4%	4%	3%	5%			
	7 Jul	2%	2%	2%	1%	1%	0%	0%	-1%	-1%	-1%	-1%	-1%	-1%	-1%	0%	1%	0%	1%	2%	1%	3%	3%	1%	3%			
59%	8 Aug	2%	2%	1%	0%	0%	0%	0%	0%	-1%	-1%	-1%	-1%	-2%	-2%	-1%	-1%	-1%	0%	-1%	1%	2%	2%	2%	2%	-4%	91%	3%
	9 Sep	3%	1%	0%	-1%	0%	0%	0%	0%	0%	0%	-1%	-1%	-2%	-3%	-3%	-5%	-4%	-2%	-1%	0%	0%	-1%	-2%	-2%			
	10 Oct	8%	8%	8%	8%	6%	5%	4%	4%	3%	3%	3%	2%	2%	1%	2%	3%	4%	6%	8%	10%	9%	6%	4%	2%			
45%	11 Nov	-1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	-2%	-2%	-2%	-1%	-1%	-2%	-1%	-1%	-1%	-2%	-3%	-2%	-41%	281%	10%
	12 Dec	-7%	-6%	-5%	-7%	-5%	-5%	-5%	-5%	-6%	-5%	-5%	-7%	-7%	-7%	-7%	-6%	-6%	-7%	-6%	-6%	-6%	-5%	-4%	-3%			
																		MIN	-10.4%	MAX	15.2%	AVG	0.225%	SD	0.0487			

Annual

SP15 Avg

Average Worst Days Vs. Exceedance

Exceedance Value		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	Sum	Abs(Sum)	Max
70%	1 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%			
	2 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%	-766%	766%	-3%
	3 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%			
	4 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%			
	5 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%	-106%	228%	6%
	6 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%			
	7 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%			
	8 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%	-269%	269%	-2%
	9 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%			
	10 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%			
	11 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%	-491%	491%	-1%
	12 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%			
																		MIN	-17.9%	MAX	5.9%	AVG	-5.7%	SD	0.0478			

Example 2: 12 seasons

Average annual capacity factors

NP15: 26.0% SP15: 16.7%

Aggregate capacity factors similar to 4-season approach

Quarterly aggregations for comparing to 4-season

NP15

NP15 Avg — Average Worst Days Vs. Exceedance

Exc. Val.	Sum	Abs(Sum)		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	Sum	Abs(Sum)	Max
27%	-14%	38%	1 Jan	4%	3%	1%	-1%	-1%	-1%	-1%	0%	0%	1%	1%	0%	-1%	-2%	-5%	-1%	-3%	-2%	-3%	-4%	-3%	0%	1%	0%			
30%	-18%	85%	2 Feb	4%	0%	-1%	-6%	-4%	-4%	-4%	-5%	-7%	-3%	-6%	-6%	-5%	0%	1%	3%	4%	0%	1%	3%	2%	4%	6%	5%	-28%	168%	6%
36%	5%	45%	3 Mar	4%	4%	6%	3%	-2%	0%	2%	2%	1%	0%	0%	0%	0%	-1%	-2%	1%	0%	1%	0%	-2%	-4%	-5%	-3%	-1%			
47%	17%	43%	4 Apr	1%	-1%	0%	-2%	-1%	0%	-1%	-2%	-2%	0%	0%	-1%	0%	2%	2%	5%	5%	4%	3%	2%	2%	1%	0%	-3%			
56%	-2%	64%	5 May	2%	2%	-1%	1%	-1%	-4%	-3%	-1%	-1%	-3%	-4%	-4%	-2%	1%	-1%	1%	6%	8%	6%	4%	-1%	0%	-3%	-4%	4%	144%	8%
62%	-11%	37%	6 Jun	0%	-1%	2%	0%	1%	1%	-2%	-2%	0%	0%	-1%	-2%	-2%	-1%	0%	0%	2%	4%	2%	0%	-2%	-2%	-4%	-2%			
67%	3%	58%	7 Jul	1%	0%	0%	0%	3%	4%	1%	-1%	-2%	-1%	-2%	-3%	-4%	-4%	-5%	-5%	-1%	1%	3%	4%	5%	4%	1%	2%			
71%	1%	79%	8 Aug	8%	8%	5%	0%	2%	3%	2%	0%	-2%	-4%	-5%	-5%	-6%	-4%	-6%	-4%	0%	-1%	2%	5%	4%	1%	0%	0%	40%	211%	11%
51%	36%	75%	9 Sep	11%	11%	8%	9%	7%	2%	1%	3%	0%	0%	-1%	-2%	-2%	-2%	-1%	-4%	0%	2%	1%	-1%	-1%	-2%	-2%	-2%			
42%	10%	68%	10 Oct	7%	4%	3%	0%	-1%	-2%	-4%	-2%	-2%	-2%	-1%	-3%	-3%	-3%	-2%	-2%	-1%	1%	5%	5%	6%	5%	1%	2%			
40%	-1%	49%	11 Nov	0%	1%	3%	3%	3%	3%	3%	3%	2%	1%	1%	2%	-1%	-2%	-1%	-2%	-2%	-3%	-2%	-2%	-2%	-2%	-3%	-3%	9%	177%	7%
28%	0%	60%	12 Dec	0%	1%	-1%	0%	-1%	-2%	-1%	-1%	-2%	-3%	-2%	-2%	-4%	-4%	-4%	-2%	-1%	1%	3%	2%	6%	6%	5%	6%			

SP15

SP15 Avg — Average Worst Days Vs. Exceedance

Exc. Val.	Sum	Abs(Sum)		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	Sum	Abs(Sum)	Max
31%	-14%	28%	1 Jan	-1%	0%	0%	0%	1%	-1%	-1%	0%	0%	0%	1%	0%	2%	2%	0%	-2%	-1%	-1%	1%	0%	-2%	-2%	-4%	-4%			
40%	-31%	56%	2 Feb	-2%	-2%	-1%	-1%	1%	0%	-1%	-1%	-4%	-6%	-6%	-5%	-5%	-4%	-2%	-2%	-1%	1%	2%	1%	3%	2%	3%	0%	-44%	117%	3%
59%	1%	34%	3 Mar	-1%	0%	-1%	1%	2%	3%	1%	-1%	-3%	-2%	-2%	-1%	-1%	-1%	-2%	-2%	1%	3%	3%	2%	0%	1%	1%	-1%			
66%	2%	21%	4 Apr	0%	0%	0%	0%	0%	-1%	0%	-1%	-2%	-1%	0%	0%	-1%	-1%	0%	1%	2%	3%	2%	1%	1%	-1%	-1%	-1%			
62%	9%	40%	5 May	-5%	-3%	-2%	0%	0%	-1%	-2%	-1%	0%	-1%	0%	0%	0%	1%	4%	3%	5%	4%	3%	2%	0%	1%	1%	1%	0%	108%	5%
75%	-11%	47%	6 Jun	3%	3%	2%	2%	3%	2%	0%	0%	-1%	-2%	-3%	-2%	-2%	-4%	-5%	-4%	-2%	-2%	1%	2%	0%	-1%	-1%	0%			
62%	-3%	27%	7 Jul	2%	1%	0%	0%	0%	-1%	-2%	-2%	-2%	-2%	-1%	-1%	-1%	-1%	-1%	0%	-1%	1%	2%	0%	1%	2%	0%	2%			
60%	1%	24%	8 Aug	2%	2%	1%	0%	0%	0%	0%	0%	-1%	-1%	-1%	-1%	-2%	-2%	-1%	-1%	-1%	0%	-1%	1%	1%	2%	2%	2%	-9%	82%	3%
57%	-7%	31%	9 Sep	3%	3%	2%	0%	0%	1%	1%	0%	0%	0%	-1%	-1%	-2%	-2%	-3%	-4%	-3%	-1%	0%	1%	0%	0%	-1%	-1%			
58%	-1%	28%	10 Oct	2%	3%	3%	2%	2%	1%	1%	0%	0%	-1%	-1%	-1%	-1%	-1%	-2%	-2%	-2%	0%	0%	0%	1%	0%	-1%	-2%			
43%	-6%	18%	11 Nov	0%	0%	1%	1%	0%	1%	1%	0%	0%	0%	1%	0%	-1%	-1%	-2%	0%	-1%	-1%	0%	0%	0%	-2%	-2%	-1%	-3%	68%	3%
34%	4%	22%	12 Dec	-2%	-1%	-2%	-1%	-1%	-1%	0%	0%	0%	0%	0%	0%	1%	1%	1%	2%	1%	0%	2%	0%	0%	1%	2%	1%			

Comparisons

Table 1:
Average Capacity Factor

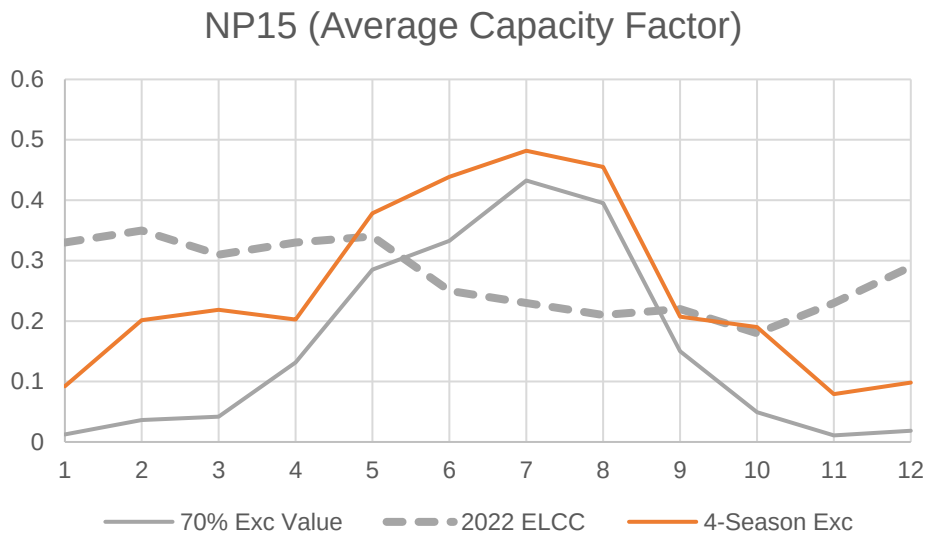
	NP15	SP15
4-season	25.4%	17.1%
1-annual	15.8%	11.2%
ELCC	27.3%	14.9%

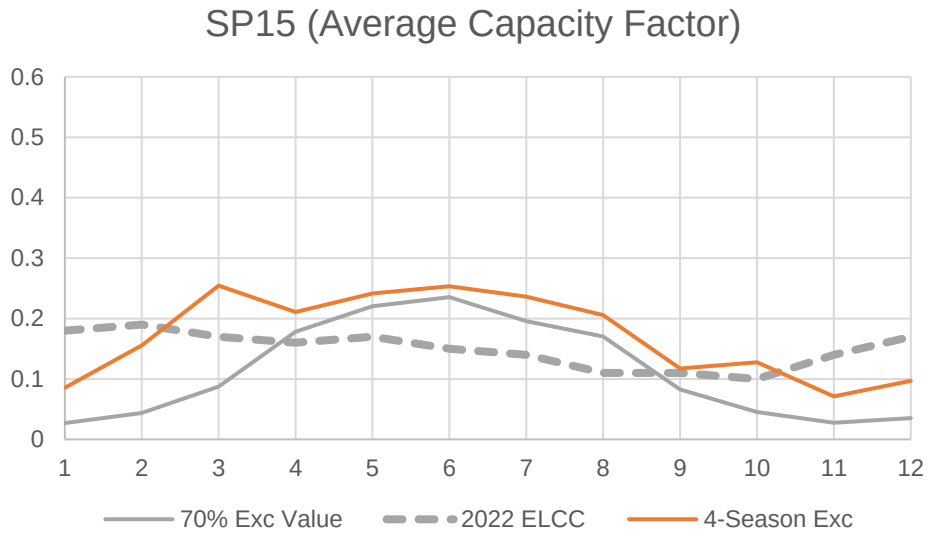
Table 2:
Average difference from Average of Top 5 Worst Days

	NP15	SP15
4-season	-0.5%	0.2%
1-annual	-10.1%	-5.7%
ELCC	1.4%	-2.0%

Table 3:
Standard deviation of the difference from Average of Top 5 Worst Days

	NP15	SP15
4-season	5.3%	4.9%
1-annual	6.2%	4.8%
ELCC	17.1%	8.5%





Benchmarking against ELCC

Quarterly maximums are *all* higher than 4-season approach

Useful for calibrating against our current risk levels. The tables show the difference between the Average production on the Top 5 Worst Days and the monthly ELCC value for NP15 and SP15.

Note: in one-third of the year (Jan-Feb, Nov-Dec), the 2022 ELCC capacity factors are *always* higher (by 7%-24%) than observed.

NP15

Average Worst Days Vs. ELCC

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	Sum	Abs(Sum)	Max
1 Jan	22%	22%	21%	20%	20%	20%	19%	19%	20%	23%	24%	24%	23%	21%	20%	20%	21%	20%	19%	17%	18%	20%	20%	20%			
2 Feb	9%	7%	8%	8%	10%	11%	10%	9%	8%	8%	8%	8%	10%	12%	13%	14%	20%	19%	17%	15%	15%	14%	14%	14%	1062%	1062%	24%
3 Mar	12%	14%	15%	14%	12%	15%	17%	17%	18%	17%	16%	17%	17%	14%	13%	12%	10%	8%	7%	6%	4%	3%	4%	5%			
4 Apr	-6%	-5%	-3%	-2%	1%	5%	8%	10%	13%	15%	17%	19%	20%	20%	18%	16%	11%	7%	5%	1%	-2%	-5%	-8%	-12%			
5 May	-18%	-17%	-16%	-14%	-9%	-7%	-2%	3%	5%	7%	10%	14%	14%	14%	11%	4%	0%	-5%	-8%	-13%	-19%	-21%	-24%	-24%	-339%	970%	20%
6 Jun	-34%	-34%	-31%	-27%	-24%	-20%	-16%	-10%	-3%	2%	6%	9%	11%	10%	7%	-1%	-11%	-18%	-22%	-26%	-30%	-33%	-34%	-37%			
7 Jul	-42%	-41%	-39%	-36%	-32%	-28%	-26%	-20%	-13%	-6%	0%	4%	4%	2%	-3%	-11%	-17%	-23%	-25%	-29%	-33%	-36%	-40%	-43%			
8 Aug	-35%	-35%	-33%	-30%	-28%	-23%	-18%	-14%	-7%	-2%	3%	4%	5%	5%	1%	-3%	-10%	-15%	-19%	-25%	-32%	-37%	-40%	-40%	-1095%	1287%	12%
9 Sep	-18%	-16%	-15%	-12%	-9%	-7%	-6%	-4%	0%	4%	8%	10%	12%	12%	10%	6%	3%	-2%	-7%	-14%	-19%	-23%	-25%	-26%			
10 Oct	-2%	-3%	-4%	-2%	-1%	0%	2%	4%	5%	6%	5%	5%	7%	6%	7%	7%	8%	7%	5%	2%	-2%	-4%	-6%	-7%			
11 Nov	12%	13%	14%	16%	17%	18%	19%	19%	19%	19%	20%	20%	18%	18%	17%	17%	16%	15%	15%	15%	13%	11%	10%	8%	767%	829%	20%
12 Dec	10%	11%	11%	12%	12%	11%	11%	12%	14%	14%	14%	14%	13%	14%	15%	17%	18%	18%	18%	18%	17%	17%	16%	15%			
																	MIN	-42.5%	MAX	24.1%	AVG	1.369%	SD	0.1706			

SP15

Average Worst Days Vs. ELCC

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	Sum	Abs(Sum)	Max
1 Jan	3%	3%	4%	4%	3%	3%	3%	5%	5%	6%	6%	5%	4%	3%	2%	1%	1%	1%	2%	2%	2%	2%	1%	0%			
2 Feb	0%	0%	0%	2%	3%	3%	4%	4%	4%	2%	0%	0%	-2%	-3%	-3%	-2%	0%	0%	1%	1%	2%	3%	3%	3%	150%	189%	7%
3 Mar	-1%	0%	1%	2%	4%	7%	7%	7%	7%	7%	6%	5%	6%	4%	2%	0%	0%	0%	0%	-1%	-2%	-2%	-1%	-1%			
4 Apr	-12%	-11%	-10%	-8%	-5%	-3%	0%	3%	5%	5%	6%	5%	4%	3%	0%	-3%	-6%	-9%	-12%	-12%	-13%	-13%	-13%	-13%			
5 May	-23%	-22%	-20%	-17%	-13%	-9%	-5%	-1%	4%	6%	8%	8%	7%	6%	3%	-2%	-8%	-14%	-16%	-17%	-19%	-20%	-20%	-19%	-475%	702%	8%
6 Jun	-16%	-14%	-12%	-10%	-7%	-4%	-1%	3%	6%	7%	8%	8%	6%	4%	0%	-4%	-9%	-12%	-15%	-17%	-20%	-21%	-20%	-19%			
7 Jul	-20%	-19%	-17%	-14%	-11%	-7%	-3%	1%	5%	7%	8%	8%	6%	4%	0%	-5%	-11%	-15%	-19%	-22%	-22%	-23%	-24%	-21%			
8 Aug	-20%	-18%	-16%	-13%	-10%	-7%	-3%	0%	3%	5%	5%	4%	3%	1%	-2%	-7%	-11%	-15%	-18%	-20%	-22%	-22%	-21%	-21%	-482%	686%	8%
9 Sep	-3%	-3%	-2%	-1%	1%	3%	4%	5%	6%	6%	6%	5%	3%	1%	0%	-3%	-5%	-6%	-8%	-10%	-11%	-11%	-10%	-10%			
10 Oct	3%	3%	3%	3%	4%	4%	5%	5%	6%	6%	5%	4%	3%	3%	2%	2%	1%	0%	0%	-1%	-1%	-1%	-2%	-2%			
11 Nov	5%	6%	7%	7%	8%	8%	9%	9%	9%	8%	8%	7%	5%	5%	5%	4%	4%	4%	4%	4%	4%	4%	4%	5%	234%	255%	9%
12 Dec	1%	2%	2%	2%	3%	3%	4%	4%	3%	3%	2%	0%	0%	-1%	-1%	-1%	0%	0%	1%	2%	1%	2%	2%	4%			
																	MIN	-23.8%	MAX	9.2%	AVG	-1.99%	SD	0.085			

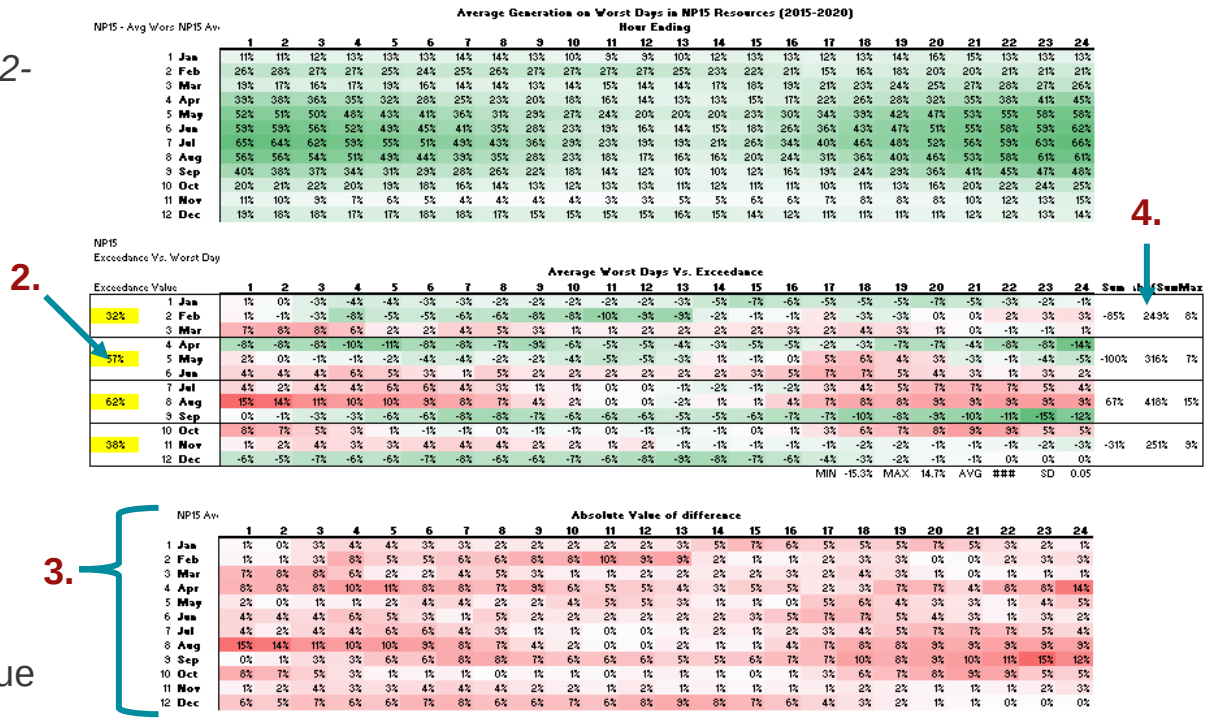
Ratepayer Benefits

1. **Accuracy**: uses a deviation minimization approach to select exceedance values and improve forecasting (reduces arbitrary choices)
2. **Continuity**: yields annual average of 1,178 MW wind capacity, more than using 70% exceedance value (766 MW) and very similar to ELCC (1,112 MW)
3. **Flexibility**: method can easily be applied to wind generation profiles in other regions and with more historical data
4. **Simplicity:** straightforward approach that can be easily replicated; can also be made more complex if needed (e.g., 12 seasons)

Backup slides

Methodology: step-by-step

1. Built on PG&E's *RA Reform - PGE - Exceedance Analysis - 2022-07-27 Workshop.xlsx*
2. Change *Average Worst Days Vs. Exceedance* table to call quarterly exceedance values (yellow)
3. Add a table whose cells are the absolute value of the corresponding *Average Worst Days vs. Exceedance* cell
4. Sum the quarterly absolute value of difference
5. Use Excel's Solver function to minimize the quarterly absolute value difference (**4.**) by changing the variable cell for quarterly exceedance value (**2.**; subject to constraint that exceedance value must be 0 to 100)

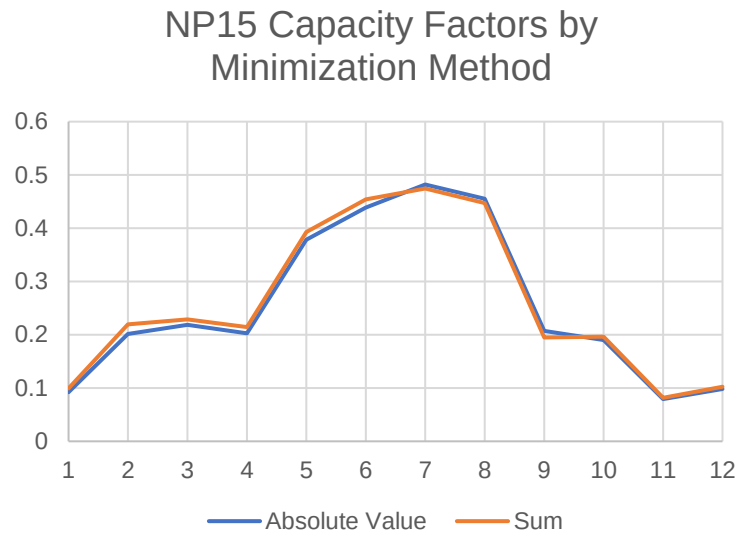


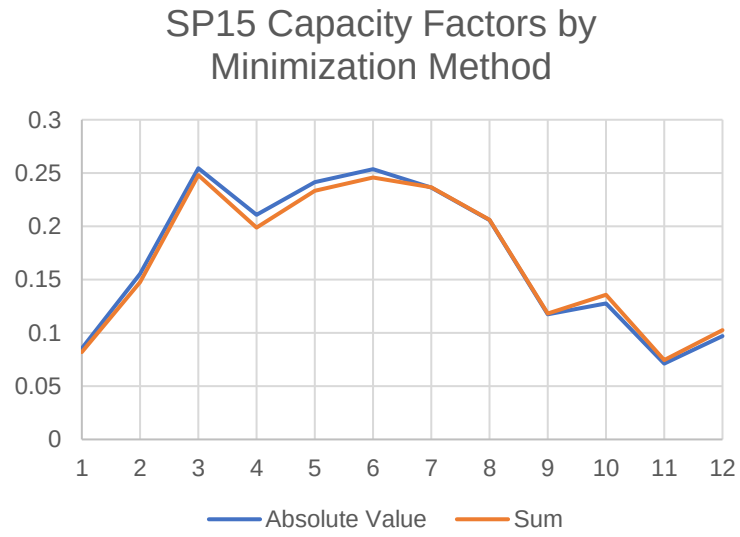
Sum vs. Absolute Value Difference

- The difference in outcomes is very minor. Could plausibly drop the absolute value step to reduce complexity.
- Blue tables demonstrate the quarterly exceedance values that emergence when minimizing the sum of the differences and the absolute value of the sum of the differences.
- Graphs show the capacity factors that translate from the exceedance values in each table.

NP15 Quarterly Exceedance Values by Method		
	SUM	ABS
Q1	30%	32%
Q2	55%	57%
Q3	63%	62%
Q4	37%	38%

SP15 Quarterly Exceedance Values by Method		
	SUM	ABS
Q1	43%	42%
Q2	67%	66%
Q3	59%	59%
Q4	44%	45%





Sum vs. Absolute Value Difference: NP15

Minimizing the absolute value yields an average CF of -0.52%, meaning it errs on the side of under-estimating performance in aggregate. Minimizing the sum tends to overestimate capacity more than absolute value in every quarter except Q3.

Absolute value

Average Worst Days Vs. Exceedance

Exceedance Value		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	Sum	Abs(Sum)	Max
	1 Jan	1%	0%	-3%	-4%	-4%	-3%	-3%	-2%	-2%	-2%	-2%	-2%	-3%	-5%	-7%	-6%	-5%	-5%	-5%	-7%	-5%	-3%	-2%	-1%			
32%	2 Feb	1%	-1%	-3%	-8%	-5%	-5%	-6%	-6%	-8%	-8%	-10%	-9%	-9%	-2%	-1%	-1%	2%	-3%	-3%	0%	0%	2%	3%	3%	-85%	249%	8%
	3 Mar	7%	8%	8%	6%	2%	2%	4%	5%	3%	1%	1%	2%	2%	2%	2%	3%	2%	4%	3%	1%	0%	-1%	-1%	1%			
	4 Apr	-8%	-8%	-8%	-10%	-11%	-8%	-8%	-7%	-9%	-6%	-5%	-5%	-4%	-3%	-5%	-5%	-2%	-3%	-7%	-7%	-4%	-8%	-8%	-14%			
57%	5 May	2%	0%	-1%	-1%	-2%	-4%	-4%	-2%	-2%	-4%	-5%	-5%	-3%	1%	-1%	0%	5%	6%	4%	3%	-3%	-1%	-4%	-5%	-100%	316%	7%
	6 Jun	4%	4%	4%	6%	5%	3%	1%	5%	2%	2%	2%	2%	2%	2%	3%	5%	7%	7%	5%	4%	3%	1%	3%	2%			
	7 Jul	4%	2%	4%	4%	6%	6%	4%	3%	1%	1%	0%	0%	-1%	-2%	-1%	-2%	3%	4%	5%	7%	7%	7%	5%	4%			
62%	8 Aug	15%	14%	11%	10%	10%	9%	8%	7%	4%	2%	0%	0%	-2%	1%	1%	4%	7%	8%	8%	9%	9%	9%	9%	9%	67%	418%	15%
	9 Sep	0%	-1%	-3%	-3%	-6%	-6%	-8%	-8%	-7%	-6%	-6%	-6%	-5%	-5%	-6%	-7%	-7%	-10%	-8%	-9%	-10%	-11%	-15%	-12%			
	10 Oct	8%	7%	5%	3%	1%	-1%	-1%	0%	-1%	-1%	0%	-1%	-1%	-1%	0%	1%	3%	6%	7%	8%	9%	9%	5%	5%			
38%	11 Nov	1%	2%	4%	3%	3%	4%	4%	4%	2%	2%	1%	2%	-1%	-1%	-1%	-1%	-1%	-2%	-2%	-1%	-1%	-1%	-2%	-3%	-31%	251%	9%
	12 Dec	-6%	-5%	-7%	-6%	-6%	-7%	-8%	-6%	-6%	-7%	-6%	-8%	-9%	-8%	-7%	-6%	-4%	-3%	-2%	-1%	-1%	0%	0%	0%			

MIN -15.3% MAX 14.7% AVG -0.52% SD 0.0526

Sum

Average Worst Days Vs. Exceedance

Exceedance Value		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	Sum	Abs(Sum)	Max
	1 Jan	2%	1%	-2%	-3%	-3%	-3%	-2%	-1%	-1%	-1%	-1%	-1%	-2%	-5%	-7%	-5%	-3%	-4%	-4%	-6%	-4%	-2%	-1%	-1%			
30%	2 Feb	4%	0%	-1%	-6%	-4%	-4%	-5%	-5%	-8%	-6%	-7%	-7%	-6%	-1%	1%	3%	3%	-1%	-1%	3%	2%	4%	6%	5%	0%	252%	9%
	3 Mar	8%	8%	9%	6%	3%	4%	5%	5%	3%	2%	2%	2%	3%	2%	3%	5%	5%	5%	4%	2%	1%	0%	1%	3%			
	4 Apr	-6%	-8%	-7%	-9%	-9%	-8%	-6%	-6%	-8%	-5%	-4%	-4%	-4%	-2%	-3%	-3%	-1%	-1%	-4%	-6%	-3%	-7%	-8%	-11%			
55%	5 May	3%	3%	0%	1%	0%	-3%	-2%	-1%	-1%	-3%	-4%	-4%	-2%	2%	-1%	2%	6%	8%	9%	5%	0%	0%	-2%	-4%	0%	321%	9%
	6 Jun	6%	6%	5%	7%	7%	5%	3%	6%	4%	5%	4%	4%	2%	3%	5%	7%	8%	8%	5%	6%	5%	2%	4%	5%			
	7 Jul	3%	1%	3%	4%	5%	6%	4%	3%	0%	1%	-1%	0%	-2%	-3%	-2%	-3%	0%	3%	5%	6%	7%	6%	3%	4%			
63%	8 Aug	14%	13%	10%	9%	10%	9%	7%	5%	3%	1%	-1%	-1%	-2%	1%	0%	3%	6%	7%	6%	9%	8%	9%	8%	9%	0%	423%	14%
	9 Sep	-3%	-4%	-5%	-5%	-6%	-7%	-10%	-10%	-9%	-7%	-7%	-7%	-6%	-6%	-7%	-8%	-7%	-10%	-10%	-12%	-11%	-12%	-17%	-14%			
	10 Oct	9%	8%	6%	4%	2%	-1%	0%	0%	-1%	0%	1%	0%	-1%	0%	0%	1%	3%	7%	8%	8%	10%	9%	7%	6%			
37%	11 Nov	2%	3%	4%	4%	4%	4%	5%	4%	3%	2%	1%	3%	-1%	-1%	0%	-1%	-1%	-2%	-1%	-1%	0%	-1%	-1%	-2%	0%	255%	10%
	12 Dec	-5%	-5%	-5%	-6%	-5%	-7%	-7%	-6%	-6%	-7%	-6%	-7%	-8%	-8%	-7%	-6%	-4%	-3%	-2%	-1%	0%	1%	1%	0%			

MIN -16.7% MAX 13.8% AVG 0.00% SD 0.0531

Sum vs. Absolute Value Difference: SP15

Minimizing the absolute value of the difference yields an average of 0.225%--a slight over-estimate of capacity in the aggregate. The difference in maximum values comes in March HE18. The total quarterly sum of differences using the absolute value method shows that it under-estimates capacity in the aggregate for Q3 and Q4, but only very marginally.

Absolute value

Average Worst Days Vs. Exceedance

Exceedance Value		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	Sum	Abs(Sum)	Max
	1 Jan	-7%	-7%	-5%	-5%	-6%	-7%	-7%	-6%	-5%	-5%	-4%	-4%	-5%	-6%	-6%	-7%	-7%	-6%	-6%	-7%	-7%	-9%	-10%	-10%			
42%	2 Feb	-3%	-3%	-3%	-2%	-1%	-2%	-3%	-2%	-5%	-7%	-7%	-5%	-6%	-5%	-3%	-3%	-2%	-2%	1%	1%	2%	2%	2%	-2%	43%	486%	15%
	3 Mar	11%	10%	11%	11%	13%	13%	13%	10%	9%	7%	6%	5%	5%	8%	10%	12%	12%	15%	14%	15%	13%	12%	11%	11%			
	4 Apr	0%	1%	0%	0%	1%	-1%	0%	0%	-1%	0%	0%	0%	0%	-1%	0%	1%	2%	4%	3%	1%	1%	-1%	-1%	-1%			
66%	5 May	-6%	-6%	-4%	-4%	-2%	-3%	-2%	-3%	-3%	-2%	-2%	-1%	0%	-1%	0%	1%	4%	3%	2%	1%	-1%	-1%	-1%	-1%	66%	170%	8%
	6 Jun	7%	7%	8%	7%	6%	6%	5%	4%	3%	1%	0%	0%	0%	-1%	-2%	0%	3%	5%	8%	6%	4%	4%	3%	5%			
	7 Jul	2%	2%	2%	1%	1%	0%	0%	-1%	-1%	-1%	-1%	-1%	-1%	-1%	0%	1%	0%	1%	2%	1%	3%	3%	1%	3%			
59%	8 Aug	2%	2%	1%	0%	0%	0%	0%	0%	-1%	-1%	-1%	-1%	-2%	-2%	-1%	-1%	-1%	0%	-1%	1%	2%	2%	2%	2%	-4%	91%	3%
	9 Sep	3%	1%	0%	-1%	0%	0%	0%	0%	0%	0%	-1%	-1%	-2%	-3%	-3%	-5%	-4%	-2%	-1%	0%	0%	-1%	-2%	-2%			
	10 Oct	8%	8%	8%	8%	6%	5%	4%	4%	3%	3%	3%	2%	2%	1%	2%	3%	4%	6%	8%	10%	9%	6%	4%	2%			
45%	11 Nov	-1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	-2%	-2%	-2%	-1%	-1%	-2%	-1%	-1%	-1%	-2%	-3%	-2%	-41%	281%	10%
	12 Dec	-7%	-6%	-5%	-7%	-5%	-5%	-5%	-5%	-6%	-5%	-5%	-7%	-7%	-7%	-7%	-6%	-6%	-7%	-6%	-6%	-6%	-5%	-4%	-3%			

MIN -10.4% MAX 15.2% AVG 0.225% SD 0.0487

Sum

Average Worst Days Vs. Exceedance

Exceedance Value		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	Sum	Abs(Sum)	Max
	1 Jan	-8%	-7%	-6%	-6%	-7%	-7%	-8%	-6%	-5%	-5%	-5%	-4%	-6%	-6%	-7%	-7%	-8%	-7%	-7%	-8%	-8%	-9%	-10%	-10%			
43%	2 Feb	-5%	-4%	-3%	-2%	-2%	-2%	-3%	-3%	-5%	-8%	-8%	-6%	-7%	-6%	-4%	-4%	-2%	-2%	0%	0%	2%	1%	0%	-2%	0%	490%	14%
	3 Mar	10%	10%	11%	11%	12%	13%	12%	10%	8%	6%	6%	3%	5%	7%	9%	11%	12%	14%	13%	13%	12%	12%	11%	11%			
	4 Apr	-1%	-3%	-1%	-1%	-1%	-1%	-1%	-2%	-3%	-1%	-1%	-1%	-2%	-2%	-1%	-1%	1%	3%	2%	0%	1%	-2%	-2%	-1%			
67%	5 May	-7%	-8%	-6%	-4%	-3%	-4%	-3%	-4%	-3%	-3%	-2%	-1%	-1%	-1%	-1%	0%	3%	2%	2%	0%	-1%	-2%	-2%	-1%	0%	180%	8%
	6 Jun	7%	6%	8%	6%	5%	5%	4%	3%	2%	0%	0%	-1%	-1%	-2%	-2%	0%	2%	4%	6%	6%	4%	3%	2%	4%			
	7 Jul	2%	2%	2%	1%	1%	0%	0%	-1%	-1%	-1%	-1%	-1%	-1%	-1%	0%	1%	0%	2%	3%	1%	3%	3%	1%	3%			
59%	8 Aug	2%	2%	1%	0%	1%	1%	0%	0%	-1%	-1%	-1%	-1%	-2%	-2%	-1%	-1%	0%	0%	0%	1%	2%	2%	2%	2%	0%	91%	3%
	9 Sep	3%	2%	1%	-1%	0%	0%	0%	0%	0%	0%	-1%	-1%	-2%	-3%	-3%	-5%	-3%	-2%	-1%	0%	0%	-1%	-2%	-2%			
	10 Oct	10%	8%	8%	8%	7%	5%	5%	4%	4%	4%	3%	2%	2%	2%	3%	5%	5%	7%	8%	10%	10%	9%	5%	5%			
44%	11 Nov	-1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%	0%	-1%	-1%	-2%	-1%	-1%	-2%	0%	0%	0%	-2%	-3%	-2%	0%	284%	10%
	12 Dec	-6%	-6%	-5%	-6%	-5%	-5%	-5%	-5%	-5%	-4%	-5%	-6%	-7%	-6%	-6%	-5%	-5%	-6%	-5%	-5%	-6%	-5%	-4%	-3%			

MIN -10.5% MAX 13.6% AVG 0.00% SD 0.0485

Minimizing during AAHs

- Potential variation: this method can be applied to CAISO's Availability Assessment Hours only (HE17-21 except for HE18-22 in Mar & Apr)
- Tables show the exceedance values calculated by minimizing the sum of the absolute value of the differences in AAHs only vs all hours (this proposal)
- Graphs show the corresponding capacity factors, along with the 70th percentile annual proposal
- Biggest differences: using AAHs very close to the 70th percentile proposal Q3 in NP15 and Q2 in SP15
- Unclear that the AAHs the most important time period to prioritize for wind

NP15 Exceedance Levels		
	AAHs	All Hours
Q1	32%	32%
Q2	62%	57%
Q3	70%	62%
Q4	43%	38%

SP15 Exceedance Levels		
	AAHs	All Hours
Q1	45%	42%
Q2	69%	66%
Q3	59%	59%
Q4	43%	45%