

MEMORANDUM

Public Utilities Department Power Resources Division

DATE: October 10, 2019

RE: Attachment 3: Avangrid Camino Solar PV + BESS Proforma Details

The following documentation describes and quantifies the information and assumptions used in the attached Avangrid Camino Solar PV + BESS financial assessment (Performa).

1. Simulation Runs

Three simulation runs were performed in order to properly analyze the financial metrics associated with this Solar PV + BESS, as described below.

- Avangrid Base Solar Pattern this run simulated the total output from the solar facility, assuming all energy flow directly to the point of interconnection (POI). (No BESS is assumed to exist in this first simulation.)
- 2. Avangrid Solar w/Batt Charge Pattern this run simulated the net output from the solar facility to the POI, after diverting sufficient solar output to fully charge the BESS each day. Note that this diverted charge also includes all BESS energy losses.
- 3. Avangrid Solar w/Batt ChargeDischarge Pattern the final run simulated both the net output from the solar facility and the full discharge output from the BESS to the POI, after accounting for all BESS energy losses.

Each simulation tracked the following variables at an hourly granularity level, before rolling-up all results into annual totals: (1) energy generation, (2) energy cost, (3) gross market revenue, and (4) net market revenue. However, note that the Proforma Calculations (shown below the PCM simulation runs) have been designed to automatically calculate all energy and capacity costs based on the specified input solar price (cell B25, \$/MWh), battery cost (cell B26, \$/kW-month) and battery size (cell B27, MW). Hence, the Proforma only needs/uses the energy generation and gross market revenue data from the simulations, since all energy and capacity costs are directly computed using the above input variables and simulated energy generation.

2. Primary Proforma Calculations: Expected Net Market Revenue from Energy Sales

Row 29: expected energy costs, for all energy reaching POI Row 30: fixed capacity cost (for BESS) Row 32: expected energy needed to fully charge BESS each day Row 33: cost of BESS charging energy, after netting out energy losses Row 35: expected discharge energy from BESS, assuming BESS fully discharges each day Row 36: expected market revenue for BESS discharge energy Row 37: expected net revenue generated by BESS, after accounting for fuel costs Row 38: expected net solar PV output sent to POI (net of energy diverted to BESS) Row 39: expected cost for net solar PV energy Row 40: simulated gross market revenue for net solar PV energy Row 42: net revenue associated with BESS, after adjusting for capacity costs (but before adding back extra FRAC-RA value) Row 43: net revenue associated with net solar PV energy

Row 44: total net energy revenue (rows 42+43)

Summary Metrics: Project TNER (sum of row 44), ROI-Energy (cell D46 / sum of rows 29+30), \$/MWh TPC (total cost / total generation), \$/MWh TPR (total revenue / total generation).

3. Secondary Proforma Calculations

Value of System RA: This 44 MW solar PV facility is expected to qualify for a certain amount of system RA, specifically 22.58% of its nameplate capacity (9.93 MW). Our 2018 IRP used a system RA value of \$4.50/kW-month, which equates to \$4.91/kW-month (or \$58.92/kW-year) in 2021 when escalated annually at 3%. The "Additional System RA Value" shown on row 54 quantifies this total value stream.

Cost and Value associated with Additional FRAC-RA: The addition of this 44 MW solar PV project to RPU's portfolio is expected to add 22 MW of additional FRAC-RA requirements to the utility. The BESS is expected to off-set approximately half of this CAISO imposed requirement (see the calculated BESS capacity values in row 50). The residual FRAC shortfall will need to be either purchased from the market or met using a RERC unit. In either scenario, the "Net Additional FRAC-RA Costs" shown on row 58 quantify these annual (implied or direct) costs. Note: RPU has already purchased 2021 FRAC-RA at a cost of \$6.92/kW-month (or \$83.04/kW-year), and again we assume that this cost will escalate 3% annually.

Implied Value of PCC-1 RECs: This project will generate Portfolio Content Category 1 RECs (specifically, the annual amounts shown on row 20). Assuming that PCC-1 RECs are valued at \$20/MWh in 2020 and escalate 3% annually, row 60 quantifies the annual implied REC value stream.

Summary Metrics: Implied System RA Value (sum of row 54), Implied Extra FRAC-RA Costs (sum of row 58), Implied REC Value (sum of row 60), Project TSV (sum of cells D46, D62, D63, and D64), ROI-Project (cell D65 / sum of rows 29+30).

Extra Notes: the calculated standard deviation for the projected 36.74 M\$ Total Net Energy Revenue (TNER) estimate is 4.72 M\$. (Results on file.)

	A	В	С	D	E	F	G	Н	I	J	К	L	М	N	0	Р	Q	R
1			Avangrid Camino Solar PV + BESS Financial Assessr	nent (Profori	na)													
2																		
3			Books	Generic														
4			Date Intervals	Annual														
5			Peak Period Label	7x24														
6			Study Portfolios	Avangrid Solar	olus Storage Fina	l Study_5-15-20	19 - SolarplusSto	orage Test Portfo	olio									
7																		
8			Value	Column Labels														
9			Row Labels	2021-01	2022-01	2023-01	2024-01	2025-01	2026-01	2027-01	2028-01	2029-01	2030-01	2031-01	2032-01	2033-01	2034-01	2035-01
10			Avengrid Rece Soler Pettern															
11 12 13 14 15	Production Cost Modeling Data: Simulation runs.	۵	windGen - Generation - Wind	1/19 521	1/18 773	1/18 030	147 596	146 553	145 820	145 091	144 666	143 644	142 926	1/12 211	1/1 795	1/10 792	1/10 088	130 388
		B	WINDCOSTS - Wind Variable Cost	4.111.828	4.091.268	4.070.812	4.058.892	4.030.206	4.010.055	3.990.004	3.978.321	3.950.204	3.930.453	3.910.801	3,899,350	3.871.791	3.852.432	3.833.169
		C	windGrossRevenue - Gross Wind Revenue	5.722.218	5.822.699	5,881,499	5.926.105	5.915.326	6.128.282	6.357.931	6.593.527	6,822,293	7.097.806	7.335.371	7,634,660	7,895,045	8.182.551	8,492,099
		D	NetRevenue - Net Revenue \$	1,610,390	1,731,431	1,810,687	1,867,212	1,885,120	2,118,227	2,367,926	2,615,206	2,872,089	3,167,353	3,424,571	3,735,310	4,023,255	4,330,120	4,658,929
16			Avangrid Solar w Batt Charge Pattern															
17		E	windGen - Generation - Wind	132,676	131,929	131,185	130,705	129,708	122,053	121,324	120,834	119,877	119,159	112,214	111,715	110,795	110,091	109,391
18		F	WINDCOSTS - Wind Variable Cost	3,648,603	3,628,044	3,607,587	3,594,399	3,566,981	3,356,463	3,336,413	3,322,940	3,296,613	3,276,862	3,085,880	3,072,169	3,046,870	3,027,511	3,008,248
19 20 21 22 23 24		G	windGrossRevenue - Gross Wind Revenue	5,189,339	5,279,525	5,329,201	5,356,192	5,335,256	5,241,589	5,431,506	5,626,227	5,810,431	6,037,465	5,929,560	6,159,656	6,363,068	6,584,664	6,820,995
		Н	NetRevenue - Net Revenue \$	1,540,737	1,651,482	1,721,614	1,761,793	1,768,275	1,885,126	2,095,093	2,303,288	2,513,818	2,760,604	2,843,680	3,087,487	3,316,199	3,557,153	3,812,746
			Avangrid Solar w Batt ChargeDischarge Pattern						4 40 700				420.026		427.004	426.002	426.400	435 400
		1	WINDCOSTS - Wind Variable Cast	147,331	146,584	145,840	145,400	144,363	142,730	142,001	141,568	140,554	139,836	138,311	137,884	136,893	136,189	135,488
		, N	windGrossRovenue - Gross Wind Revenue	4,051,608	4,031,049	4,010,593	3,998,508	5,909,980	3,925,088	3,905,038	3,893,122	3,805,237	3,845,480	3,803,501	3,791,810	3,704,551	3,745,192	3,725,930
24		I.	NetRevenue - Net Revenue S	1,976 044	2,105 728	2,193,042	2,244 255	2,277 510	2,625,660	2,882 965	3,145 172	3,403,151	3,703 787	4,058 9/18	4,374 706	4,674 5/17	4,996 134	5,037,420
26		-		1,570,011	2,103,720	2,199,019	2,211,233	2,277,510	2,023,000	2,002,505	3,113,123	5,105,151	3,703,707	1,050,510	1,57 1,700	1,07 1,0 17	1,550,151	3,331,130
27	blar Price (\$/MWh)	\$27.70																
28	Battery Cost (\$/kW-month)	\$6.48																
29	Battery Size (MW)	11																
30																		
31		l x \$27.70	Energy Cost (net to POI)	\$4,081,075	\$4,060,366	\$4,039,761	\$4,027,588	\$3,998,859	\$3,953,634	\$3,933,438	\$3,921,435	\$3,893,348	\$3,873,453	\$3,831,223	\$3,819,393	\$3,791,929	\$3,772,430	\$3,753,027
32			Capacity Cost (for BESS)	\$855,360	\$855,360	\$855,360	\$855,360	\$855,360	\$855,360	\$855,360	\$855,360	\$855,360	\$855,360	\$855,360	\$855,360	\$855,360	\$855,360	\$855,360
33 34 35	Primary Proforma Calculations: Expected Net Market Revenue from Energy Sales	A E	Batton (Charge (MM/h)	16.945	16.945	16.945	16 901	16.945	22 767	22 767	12 022	22 767	22 767	20.007	20.070	20.007	20.007	20.007
		(I-E) x \$27.70	Battery Power Cost (net of losses)	\$405 937	\$405,937	\$405,937	\$407.049	\$405 937	\$572,760	\$572,760	\$574 329	\$572,760	\$572,760	\$722 901	\$724 881	\$722 901	\$722 901	\$722.901
36		(, +		+,	+,	+,	<i>+</i> ,	+,	+=-=/-==	<i>+•••_,•••</i>	<i>to: 1,010</i>	<i>+,</i>	<i>+--,....</i>	÷· ==,= = =	<i></i>	<i></i>	+	<i></i>
37		I - E	Battery Discharge (MWh)	14,655	14,655	14,655	14,695	14,655	20,677	20,677	20,734	20,677	20,677	26,098	26,169	26,097	26,098	26,098
38		K - G	Battery Discharge Revenue	\$838,313	\$857,252	\$874,441	\$886,571	\$912,241	\$1,309,158	\$1,356,496	\$1,412,017	\$1,457,957	\$1,511,808	\$1,932,949	\$2,006,866	\$2,076,029	\$2,156,662	\$2,236,425
39			Battery Net Revenue after Fuel Cost	\$432,376	\$451,315	\$468,504	\$479,523	\$506,305	\$736,398	\$783,736	\$837,688	\$885,197	\$939,048	\$1,210,048	\$1,281,985	\$1,353,128	\$1,433,761	\$1,513,524
40		E	Solar Gen (MWh)	132,676	131,929	131,185	130,705	129,708	122,053	121,324	120,834	119,877	119,159	112,214	111,715	110,795	110,091	109,391
41		E x \$27.70	Solar Gen Cost	\$3,675,138	\$3,654,429	\$3,633,824	\$3,620,540	\$3,592,922	\$3,380,874	\$3,360,678	\$3,347,106	\$3,320,588	\$3,300,694	\$3,108,323	\$3,094,512	\$3,069,029	\$3,049,529	\$3,030,127
42		G	Solar Gen Revenue	\$5,189,339	\$5,279,525	\$5,329,201	\$5,356,192	\$5,335,256	\$5,241,589	\$5,431,506	\$5,626,227	\$5,810,431	\$6,037,465	\$5,929,560	\$6,159,656	\$6,363,068	\$6,584,664	\$6,820,995
45			Battery Net Revenue after fixed Canacity Cost	-\$422.984	-\$404.045	-\$386.856	-\$375.837	-\$349.055	-\$118.967	-\$71.624	-\$17.672	\$29.837	\$83 688	\$354 688	\$426.625	\$497 768	\$578.401	\$658 164
45			Solar Net Revenue	\$1,514,202	\$1.625.096	\$1,695,377	\$1.735.652	\$1.742.333	\$1.860.715	\$2.070.828	\$2,279,121	\$2,489,843	\$2,736,772	\$2.821.237	\$3.065.144	\$3,294,040	\$3,535,135	\$3,790,868
46			Net Revenue	\$1,091,217	\$1,221,051	\$1,308,521	\$1,359,815	\$1,393,278	\$1,741,753	\$1,999,204	\$2,261,449	\$2,519,680	\$2,820,460	\$3,175,926	\$3,491,769	\$3,791,808	\$4,113,536	\$4,449,032
47																		
48			Project Total Net Energy Revenue	\$36,738,500		ROI-Energy	51.3%											
49			Implied \$/MWh Total Project Cost:	\$33.75														
50			Expected \$/MWh Total Project Revenue (energy only):	\$51.07														
51			Calculated Canacity @ 4 hours (off-sets some ERAC costs)	10.04	10.04	10.04	10.06	10.04	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00
53 54 55 56			Solar NOC System RA Capacity Credit	9,93	9,93	9,93	9,93	9,93	9,93	9,93	9,93	9,93	9,93	9,93	9,93	9,93	9,93	9,93
				5.55	5.55	5.55	5.55	5.55	5.55	5.55	5.55	5.55	5.55	5.55	5.55	5.55	5.55	5.55
	Secondary Proforma Calculations: Value of System-RA, Cost of additional FRAC-RA, Implied Value of PCC-1 RECs	3.0%	Annual value of System RA for MQC (\$/kW-year)	\$58.92	\$60.69	\$62.51	\$64.38	\$66.31	\$68.30	\$70.35	\$72.46	\$74.64	\$76.88	\$79.18	\$81.56	\$84.01	\$86.53	\$89.12
			Additional System RA Value	\$585,252	\$602,810	\$620,894	\$639,521	\$658,707	\$678,468	\$698,822	\$719,787	\$741,380	\$763,622	\$786,530	\$810,126	\$834,430	\$859,463	\$885,247
57		3.0%	Annual cost of FRAC-RA (\$/kW-year)	\$83.04	\$85.53	\$88.10	\$90.74	\$93.46	\$96.27	\$99.15	\$102.13	\$105.19	\$108.35	\$111.60	\$114.95	\$118.40	\$121.95	\$125.61
58			Additional value of FRAC-RA supplied by BESS	\$833,514	\$858,519	\$884,275	\$913,299	\$938,127	\$1,058,927	\$1,090,695	\$1,123,416	\$1,157,118	\$1,191,832	\$1,227,587	\$1,264,415	\$1,302,347	\$1,341,417	\$1,381,660
59 60 61 62			Expected cost of 22 MW of FRAC-RA to offset solar PV	(\$1,826,880)	(\$1,881,686)	(\$1,938,137)	(\$1,996,281)	(\$2,056,170)	(\$2,117,855)	(\$2,181,390)	(\$2,246,832)	(\$2,314,237)	(\$2,383,664)	(\$2,455,174)	(\$2,528,829)	(\$2,604,694)	(\$2,682,835)	(\$2,763,320)
		2.0%	Implied value of PCC 1 PECs (offer larger)	(\$993,366)	(\$1,023,167)	(\$1,053,862)	(\$1,082,982)	(\$1,118,042)	(\$1,058,927)	(\$1,090,695)	(\$1,123,416)	(\$1,157,118)	(\$1,191,832)	(\$1,227,587)	(\$1,264,415)	(\$1,302,347)	(\$1,341,417)	(\$1,381,660)
		3.0%	Implied value of PCU-1 KEUS (atter losses)	\$20.60	\$21.22	\$21.85	\$22.51	\$23.19	\$23.88	\$24.60	\$25.34	\$26.10	\$25.88	\$27.68	\$28.52	\$29.37	\$30.25	\$31.16
62				şs,035,023	\$3,11U,211	,20U,20U,20	ŞS,∠/Z,98b	əə,ə47,129	ə,408,553	ə,492,875	ə,580,084	23,100,824	ə,/58,554	əə,629,104	\$2,931,799	34,UZU,033	\$4,113,322	ə4,221,729
64			Implied System BA Value	\$10.885.058						<u> </u>			<u> </u>	<u> </u>	<u> </u>			
65 66			Implied Extra FRAC-RA Cost	(\$17,410.835)														
			Implied REC Value	\$53,990,319														
67			Project Total System Value	\$84,203,042		ROI-Project	117.6%											
68																		