

Middle School Solar and Battery financial model

February 8, 2023 Light Board Meeting



**CONCORD MUNICIPAL
LIGHT PLANT**
ELECTRIC | BROADBAND | ENERGY MANAGEMENT

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Progress Design

- What follows is an analysis of the progress design at this stage.
- Solar Design Associates (“SDA”), CMLP’s design consultant, is still working with Symmes, Maini & McKee Associates (“SMMA”) on the final location for some of the rooftop obstructions.
- All specifications and costs are subject to change.

Specification Summary

Solar

- 503 kW DC rooftop
- 773 kW DC canopies
- 1,276 kW DC total capacity
- Beginning of Life (BoL)
annual estimated production
= 1,554,336 kWh (14%
capacity factor)

Battery

- 1 MVA apparent DC power
- 4 MWH energy (BoL DC)
- 97% 1-way efficiency
- Auxiliary load
 - 4 kW at 0% load
 - 36 kW at 100% load

Solar Assumptions

- 1,276.52 kW DC nameplate capacity; \$3,964,450 PV cost
- \$3,106/kW for PV only; \$3,615/kW all costs included
- 0.5% annual degradation
- 2025 market value \$0.06/kWh; RECs \$0.025

	Output during peak	Peak HE
January	0	18
February	0	19
March	22	18
April	73	18
May	132	18
June	168	18
July	461	16
August	408	16
September	23	18
October	0	19
November	0	18
December	0	18
average	107	

Capital Cost (w/out IRA)	Units	\$4,614,450
Rooftop PV System	\$2.50/W	\$1,258,425
Canopy PV System	\$3.50/W	\$2,706,025
Engineering	\$	250,000
O&M Y1	\$	10,000
Warranty Y1		15,000
Shipping + Duties	\$	40,000
Installation & BoP	\$	150,000
Interconnection	\$	210,000

Battery Assumptions

- 970 kW Power (active at POC)
- 3,850 kWh Energy Discharge (active at POC)
- 1.5% annual degradation
- 365 cycles per year

Forecast Accuracy	%
RNS & LNS	83
ICAP	95
Capacity reserve margin	30
Additional arbitrage value	yes

Escalators	%
Commodity price	1.5
Managed Services	2.5
O&M	2.5
RNS year 1-3	6.0
RNS > year 3	3.0

Cost (w/out IRA)	Units	\$2,938,800
Energy Storage System	\$600/kWh	\$2,428,800
Engineering	\$	\$100,000
Managed Services	\$	30,000
O&M + Warranty Y1	\$/yr	25,000
Shipping + Duties	\$	100,000
Installation & BoP	\$	300,000
Interconnection	\$	10,000

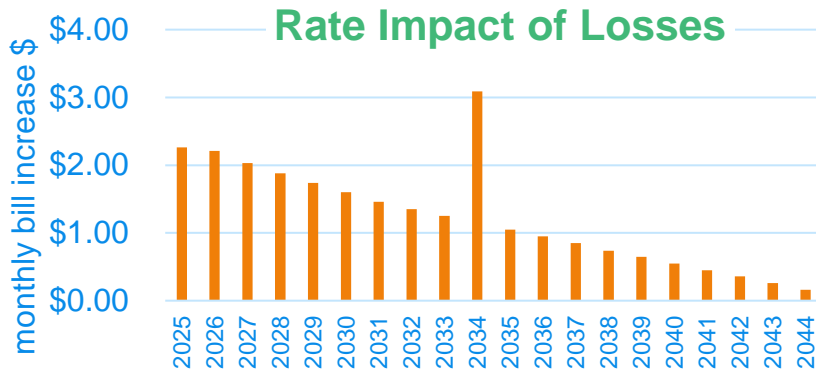
Summary Financials

Without IRA Credit

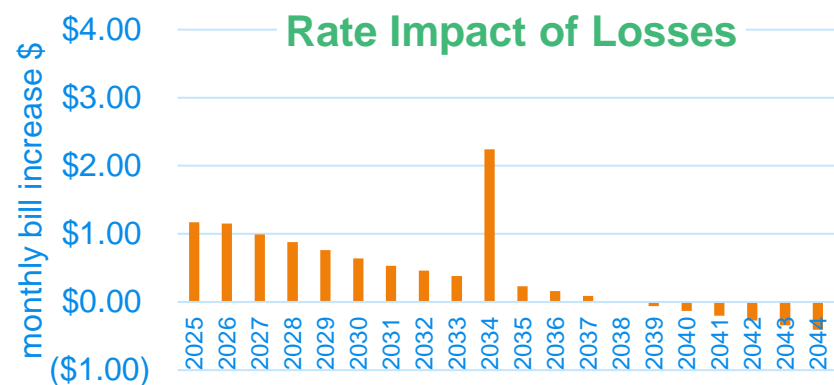
X 1,000	Capital Cost	20-year NPV
Solar	4,614	(2,678)
Battery	2,939	(785)
Total	7,553	(3,463)

With IRA + ARPA Credits

X 1,000	Capital Cost	20-year NPV
Solar	3,604	(1,167)
Battery	2,319	(165)
Total	5,923	(1,332)



Average customer 869 kWh/mo.



Average customer 869 kWh/mo.

Solar NPV – No IRA Funds

	<i>units</i>			2025	2026	2034	2044
				1	2	10	20
solar output	<i>kWh</i>	degradation	0.5%	1,554,336	1,546,564	1,485,773	1,413,134
<u>OPEX</u>	\$			(25,000)	(25,625)	(243,649)	(39,966)
Inverter replacement	\$	\$0.20/watt	2.5%			(212,427)	
O&M	\$	escalation	2.5%	(10,000)	(10,250)	(12,489)	(15,987)
Warranty	\$	escalation	2.5%	(15,000)	(15,375)	(18,733)	(23,980)
<u>Debt Service</u>	%	interest rate	5%	(461,445)	(449,909)	(357,620)	(242,259)
Annual Principal	\$			(230,723)	(230,723)	(230,723)	(230,723)
Annual Interest	\$			(230,723)	(219,186)	(126,897)	(11,536)
<u>Total Cost</u>	\$			(486,445)	(475,534)	(601,268)	(282,225)
Revenues	\$			\$170,230	\$175,222	\$201,836	\$220,697
market value	<i>\$/kWh</i>	escalation	1.5%	\$0.0600	\$0.0609	\$0.0686	\$0.0796
RE value	<i>\$/kWh</i>	escalation	(1%)	\$0.0250	\$0.0250	\$0.0240	\$0.0217
prod value	\$			\$132,119	\$132,850	\$137,610	\$143,201
peak deferral value	\$			\$38,111	\$42,372	\$64,226	\$77,497
Cashflow	\$			(316,215)	(300,312)	(399,433)	(61,527)
NPV	5%			(\$2,678,186)			

Solar NPV – with IRA+ARPA Funds

	<i>units</i>			2025	2026	2034	2044
solar output	<i>kWh</i>	degradation	0.5%	1,554,336	1,546,564	1,485,773	1,413,134
				1	2	10	20
<u>OPEX</u>	\$			(25,000)	(25,625)	(243,649)	(39,966)
Inverter replacement	\$	\$0.20/watt	2.5%			(212,427)	
O&M	\$	escalation	2.5%	(10,000)	(10,250)	(12,489)	(15,987)
Warranty	\$	escalation	2.5%	(15,000)	(15,375)	(18,733)	(23,980)
<u>Debt Service</u>	%	interest rate	5%	(310,352)	(302,593)	(240,522)	(162,935)
Annual Principal	\$			(155,176)	(155,176)	(155,176)	(155,176)
Annual Interest	\$			(155,176)	(147,417)	(85,347)	(7,759)
<u>Total Cost</u>	\$			(335,352)	(328,218)	(484,171)	(202,901)
Revenues	\$			\$170,230	\$175,222	\$201,836	\$220,697
market value	\$/kWh	escalation	1.5%	\$0.0600	\$0.0609	\$0.0686	\$0.0796
RE value	\$/kWh	escalation	(1%)	\$0.0250	\$0.0250	\$0.0240	\$0.0217
prod value	\$			\$132,119	\$132,850	\$137,610	\$143,201
peak deferral value	\$			\$38,111	\$42,372	\$64,226	\$77,497
Cashflow	\$			(165,122)	(152,996)	(282,335)	17,797
NPV	5%			(\$1,167,251)			

Battery NPV – No IRA Funds

Battery			2024	2025	2026	2034	2044
	units	Year	0	1	2	10	20
BESS							
Energy available at POC	MWh			3.85	3.79	3.33	2.75
Energy avail after degradation	% available	-1.5%		100%	98.5%	86.5%	71.5%
Duration at P nom	hrs		-	3.98	3.92	3.45	2.85
OPEX							
	\$			(37,280)	(63,764)	(243,422)	(97,585)
Inverter replacement	\$/w	\$ 0.20				(166,411)	
Managed services	\$	2.5%		(30,000)	(30,750)	(37,466)	(47,960)
O&M & Warranties	\$	2.5%			(25,625)	(31,222)	(39,966)
Energy costs for auxiliary	\$	0.004		(2,102)	(2,134)	(2,404)	(2,790)
Energy loss round-trip	\$	0.036		(5,177)	(5,255)	(5,920)	(6,870)
Debt Service							
	%	5%		(293,880)	(286,533)	(227,757)	(154,287)
Annual Principal	\$			(146,940)	(146,940)	(146,940)	(146,940)
Annual Interest	\$			(146,940)	(139,593)	(80,817)	(7,347)
Market value of energy	\$/MWh	1.5%		60	61	69	80
Total Cost							
	\$			(331,160)	(350,297)	(471,179)	(251,872)
Revenues							
	\$			205,933	218,901	266,525	281,724
Total peak reduction value	\$/kW-y			186	203	292	381
Energy arbitrage	\$			26,372	25,977	22,812	18,856
Cash-flow							
	\$		0	(125,227)	(131,395)	(204,654)	29,852
NPV	\$			(784,565)			

Battery NPV – 25.5% IRA Funds

Battery			2024	2025	2026	2034	2044
	units	Year	0	1	2	10	20
BESS							
Energy available at POC	MWh			3.85	3.79	3.33	2.75
Energy avail after degradation	% available	-1.5%		100%	98.5%	86.5%	71.5%
Duration at P nom	hrs		-	3.98	3.92	3.45	2.85
<u>OPEX</u>							
	\$			(37,280)	(63,764)	(243,422)	(97,585)
Inverter replacement	\$/w	\$ 0.20				(166,411)	
Managed services	\$	2.5%		(30,000)	(30,750)	(37,466)	(47,960)
O&M & Warranties	\$	2.5%			(25,625)	(31,222)	(39,966)
Energy costs for auxiliary	\$	0.004		(2,102)	(2,134)	(2,404)	(2,790)
Energy loss round-trip	\$	0.036		(5,177)	(5,255)	(5,920)	(6,870)
<u>Debt Service</u>							
	%	5%		(231,946)	(226,147)	(179,758)	(121,771)
Annual Principal	\$			(115,973)	(115,973)	(115,973)	(115,973)
Annual Interest	\$			(115,973)	(110,174)	(63,785)	(5,799)
Market value of energy	\$/MWh	1.5%		60	61	69	80
<u>Total Cost</u>							
	\$			(269,225)	(289,911)	(423,180)	(219,357)
<u>Revenues</u>							
	\$			205,933	218,901	266,525	281,724
Total peak reduction value	\$/kW-y			186	203	292	381
Energy arbitrage	\$			26,372	25,977	22,812	18,856
<u>Cash-flow</u>							
	\$		0	(63,293)	(71,009)	(156,654)	62,367
NPV	\$			(165,221)			

APPENDIX

System Specification Detail

PV SYSTEM SUMMARY						
ARRAYS	FIXED TILT	AZIMUTH	MODULES	DC POWER	AC POWER	ANNUAL AC ENERGY
WALKWAY CANOPY	7°	82°	430/ 470W	202.10 kWdc	200.0 kWac	235,939 kWhr/yr
NORTH PARKING CANOPIES	7°	262°/82°	693/ 470W	325.71 kWdc	308.3 kWac	383,511 kWhr/yr
SOUTH PARKING CANOPIES	7°	VARIABLES	522/ 470W	245.34 kWdc	216.6 kWac	289,554 kWhr/yr
ROOFTOP	10°	VARIABLES	1,071/ 470W	503.37 kWdc	500.0 kWac	645,332 kWhr/yr
TOTAL	-	-	2,716 MODULES	1,276.52 kWdc	1,224.9 kWac	1,554,336 kWhr/yr

BESS SYSTEM SUMMARY		
AC POWER	FULL LOAD RUNTIME	ENERGY STORAGE
1000 KW	4-HOUR	4,048 kWhr

ESTIMATED ANNUAL ENERGY PRODUCTION BASED ON:
 HELIOSCOPE CALCULATOR
 LAT, LON 42.44, -71.40 WEATHER DATA
 PREMIUM MODULE
 16% SYSTEM LOSSES
 FIXED TILT
 98.5% INV EFFICIENCY

Solar Peak Reduction Savings

			2025	2026	2027	2044
avg kW output	kW	-0.5%	107	107	106	97
RNS forecast	\$/kW-y	3.0%	\$169	\$180	\$193	\$319
	\$		\$18,072	\$19,240	\$20,484	\$31,091
LNS forecast	\$/kW-y	3.0%	\$9	\$9	\$10	\$16
	\$		\$965	\$989	\$1,013	\$1,538
peak kW output	kW	-0.5%	408	406	404	371
ICAP forecast	\$/kW-y		\$36	\$42	\$48	\$93
	\$		\$19,075	\$22,142	\$25,179	\$44,867
Reserve margin	%		30%	30%	30%	30%
total peak reduction			\$38,111	\$42,372	\$46,677	\$77,497

Battery Revenue

Revenues	\$		205,933	218,901	266,525	281,724
Power (Active at POC)	<i>kW</i>		966	952	836	691
Total peak reduction value	<i>\$/kW-y</i>		186	203	292	381
RNS reduction	<i>\$/kW-y</i>		136	145	191	257
RNS forecast	<i>\$/kW-y</i>	3%	169	180	237	319
	<i>\$/kW-mo</i>		14	15	20	27
Accuracy	%	83%				
LNS reduction	<i>\$/kW-y</i>		7	7	9	13
LNS forecast	<i>\$/kW-y</i>	3%	9	9	12	16
	<i>\$/kW-mo</i>		1	1	1	1
Accuracy	%	83%				
ICAP reduction	<i>\$/kW-y</i>		43	50	91	111
ICAP forecast	<i>\$/kW-y</i>		36	42	76	93
	<i>\$/kW-mo</i>		3	4	6	8
Accuracy	%	95%				
Reserve margin	%		0.3	0.3	0.3	0.3
Energy arbitrage	\$		26,372	25,977	22,812	18,856

Arbitrage Value

Average of Real Time LMP

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	avg	avgarb value	
2014	\$53	\$52	\$46	\$46	\$46	\$50	\$69	\$70	\$69	\$70	\$72	\$71	\$69	\$67	\$64	\$62	\$75	\$89	\$80	\$79	\$74	\$61	\$54	\$46	\$68	\$82	\$21
1	\$138	\$143	\$120	\$112	\$125	\$144	\$220	\$191	\$197	\$188	\$196	\$177	\$162	\$157	\$146	\$139	\$180	\$234	\$209	\$195	\$185	\$155	\$124	\$104	\$160	\$205	\$74
2	\$128	\$125	\$125	\$125	\$108	\$112	\$166	\$194	\$177	\$174	\$173	\$172	\$172	\$157	\$142	\$131	\$152	\$212	\$194	\$191	\$175	\$139	\$134	\$105	\$161	\$187	\$52
3	\$102	\$100	\$87	\$95	\$93	\$95	\$153	\$140	\$137	\$141	\$136	\$132	\$120	\$110	\$104	\$95	\$103	\$120	\$138	\$154	\$141	\$109	\$107	\$91	\$116	\$138	\$4
4	\$37	\$34	\$34	\$32	\$33	\$36	\$45	\$48	\$46	\$47	\$48	\$49	\$45	\$44	\$42	\$42	\$43	\$43	\$41	\$52	\$54	\$42	\$35	\$34	\$45	\$47	(\$2)
5	\$30	\$28	\$26	\$25	\$25	\$27	\$34	\$37	\$40	\$39	\$41	\$42	\$39	\$38	\$40	\$39	\$41	\$40	\$39	\$42	\$43	\$37	\$32	\$32	\$40	\$41	\$0
6	\$31	\$29	\$27	\$26	\$28	\$24	\$30	\$33	\$34	\$37	\$44	\$44	\$44	\$43	\$58	\$49	\$51	\$51	\$44	\$41	\$42	\$39	\$34	\$33	\$47	\$45	\$4
7	\$29	\$27	\$24	\$22	\$22	\$27	\$30	\$29	\$29	\$35	\$38	\$43	\$44	\$47	\$50	\$52	\$65	\$62	\$46	\$44	\$43	\$37	\$33	\$29	\$46	\$54	\$16
8	\$25	\$22	\$21	\$19	\$20	\$22	\$22	\$23	\$24	\$28	\$33	\$35	\$34	\$36	\$36	\$41	\$54	\$45	\$35	\$35	\$43	\$31	\$25	\$25	\$35	\$42	\$9
9	\$28	\$28	\$26	\$24	\$24	\$24	\$29	\$31	\$31	\$33	\$35	\$38	\$49	\$63	\$41	\$39	\$51	\$44	\$43	\$60	\$41	\$35	\$30	\$27	\$48	\$49	(\$4)
10	\$24	\$24	\$21	\$20	\$20	\$22	\$31	\$36	\$35	\$34	\$32	\$33	\$33	\$32	\$31	\$30	\$36	\$45	\$47	\$41	\$35	\$29	\$26	\$23	\$32	\$42	\$12
11	\$36	\$32	\$30	\$30	\$31	\$36	\$47	\$54	\$51	\$50	\$49	\$51	\$50	\$45	\$43	\$45	\$59	\$76	\$57	\$51	\$48	\$44	\$39	\$34	\$47	\$61	\$29
12	\$33	\$32	\$22	\$26	\$32	\$34	\$27	\$38	\$36	\$44	\$47	\$44	\$42	\$42	\$39	\$41	\$77	\$103	\$79	\$52	\$42	\$41	\$38	\$26	\$42	\$78	\$61

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
from HE	17	17	18	19	18	18	17	17	17	17	17	17
to HE	20	20	21	22	21	21	20	20	20	20	20	20

Rate Impacts

w/ IRA + ARPA credits		2025	2026	2027	2034	2044				
	<i>Year</i>	1	2	3	10	20				
solar cashflow		(165,122)	(152,996)	(140,832)	(282,335)	17,797				
battery cashflow		(63,293)	(71,009)	(53,627)	(156,654)	62,367				
combined cashflow		(228,414)	(224,006)	(194,458)	(438,990)	80,164				
sales	170,000,000	(\$0.00134)	(\$0.00132)	(\$0.00114)	(\$0.00258)	\$0.00047				
2023 R-1 T-1 rate	\$0.19120	\$0.19254	\$0.19252	\$0.19234	\$0.19378	\$0.19073				
		0.7%	0.7%	0.6%	1.4%	(0.2%)				
average customer monthly increase	\$	1.17	\$	1.15	\$	0.99	\$	2.24	\$	(0.41)

w/out IRA or ARPA credits		2025	2026	2027	2034	2044				
	<i>Year</i>	1	2	3	10	20				
solar cashflow		(316,215)	(300,312)	(284,371)	(399,433)	(61,527)				
battery cashflow		(125,227)	(131,395)	(112,464)	(204,654)	29,852				
combined cashflow		(441,442)	(431,708)	(396,835)	(604,086)	(31,676)				
sales	170,000,000	(\$0.00260)	(\$0.00254)	(\$0.00233)	(\$0.00355)	(\$0.00019)				
2023 R-1 T-1 rate	\$0.19120	\$0.19380	\$0.19374	\$0.19353	\$0.19475	\$0.19139				
		1.4%	1.3%	1.2%	1.9%	0.1%				
average customer monthly increase	\$	2.26	\$	2.21	\$	2.03	\$	3.09	\$	0.16

UMass Amherst Canopy



River Valley Co-op Solar







SOLAR POWER



LOT F

PLEASE YIELD TO PEDESTRIANS