

Underwater solar panels in Aotearoa New Zealand: An economic analysis Supplementary Material

Debt sizing

Silicon solar cells	Debt Sizing									
20,0% % \$10,70 per KW-Year \$14,00 per KW-Year \$80,00 per MWh \$80,00 per MWh \$2,0% % 2,	Silicon solar cells		PSC		Gainp			Ga	inp late scenario	
\$10,70 per KW-Year \$80,00 per MWh 2,0% % 2,0	10,0	MW	10,0	MW		10,0	MW		10,0	MW
\$80,00 per MWh 2,0% % 3,0% Ratio 3,30x Ratio 1,30x Ratio 1,00 NZD 1 000 NZD O00 1 9% 1 9800,000 PER KW 1 98,000 PER KW 1 1 98,000 PER KW 1 1 98,000 PER KW 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	20,0%	%	39,4%	%		52,5%	%		52,5%	%
2,0% % 2,0% % 2,0% % 2,0% % 2,0% % 2,0% % 3,	\$10,70	per KW-Year	\$14,00	per KW-Year		\$83,25	per KW-Y	ear	\$23,40	per KW-Year
2,0% % 1,30x Ratio 1,00 NZD 1,30x Ratio 1,	\$80,00	per MWh	\$80,00	per MWh		\$80,00	per MWh		\$80,00	per MWh
1,30x Ratio 8,0% % 8 760 Hours 1 000 NZD 1 000 NZD 1 1 000 NZD 0 9% 1 14,61 \$/MWh 7 6,12 \$/MWh 3 339,69 \$/MWh 9 5,48 \$/MWh	2,0%	%	2,0%	%		2,0%	%		2,0%	%
8,0% % 8,760 Hours 1 000 NZD 8 760 Hours 1 000 NZD 000 9% 9% 9% 9 114,61 \$/MWh 23,1% % 21,6% % 21,6% % 22,0% % 22,0% % 22,0% % 22,0% % 22,0% % 22,0% % 22,0% % 22,0% % 31,30x Ratio 8,0% %	2,0%	%	2,0%	%		2,0%	%		2,0%	%
8 760 Hours 1 000 NZD 1 000 NZD \$2 140,000 per KW 21 400,000 NZD 000 9% 114,61 \$/MWh	1,30x	Ratio	1,30x	Ratio		1,30x	Ratio		1,30x	Ratio
1 000 NZD	8,0%	%	8,0%	6 %		8,0%	%		8,0%	%
\$2 140,00 per KW 21 400,000 NZD 000 9% 9% 9% 104,61 \$/MWh 10,0 MW 23,1% % 21,6% % 20,0% % 2,0% % 2,0% % 2,0% % 13,30 Ratio 8,0% % 8 760 Hours 1000 NZD	8 760	Hours	8 760	Hours		8 760	Hours		8 760	Hours
21 400,000 NZD 000 9% 166 500,000 NZD 000 9% 9% 9% 9% 9% 9% 9% 95,48 \$/MWh 114,61 \$/MWh	1 000	NZD	1 000	NZD		1 000	NZD		1 000	NZD
9% 114,61 \$/MWh	\$2 140,00	per KW	\$2 800,00	per KW	\$16	650,00	per KW		\$4 680,00	per KW
114,61 \$/MWh OSC Cote 10,0 MW 23,1% % \$19,35 per KW-Year \$80,00 per MWh 2,0% % 2,0% % 2,0% % 2,0% % 1,30x Ratio 8,0% % 8 760 Hours 1 000 NZD \$3 8700,000 NZD 000 9% Cote Counterfactual : LPV farm 10,0 kW 20,0% % 20,0%	21 400,000	NZD 000	28 000,000	Hours	166 500	0,000	NZD 000		46 800,000	NZD 000
OSC Cotte Counterfactual: LPV farm 10,0 MW 10,0 MW 23,1% % 21,6% % 20,0% % \$19,35 per KW-Year \$13,10 per KW-Year \$1,50 per KW-Year \$1,50 per KW-Year \$80,00 per MWh \$80,00 per MWh \$80,00 per MWh \$2,0% % 8,0% % 8,0% % 8,0% % 8,0% % 8,0% % 8,0% % 8,0% % 8,0% % 8,0% % 1,00 NZD 1,00 NZD 1,00 NZD 1,00 NZD 1,00 NZD 1,00 NZD </th <th>9%</th> <th></th> <th>9%</th> <th>6</th> <th></th> <th>9%</th> <th></th> <th></th> <th>9%</th> <th></th>	9%		9%	6		9%			9%	
10,0 MW 23,1% % 21,6% % 21,6% % 20,0% % \$19,35 per KW-Year \$80,00 per MWh 2,0% % 2,0% % 2,0% % 2,0% % 2,0% % 2,0% % 2,0% % 2,0% % 2,0% % 3,30x Ratio 8,0% % 8 760 Hours 1 000 NZD \$3 870,00 per KW 38 700,000 NZD 000 9% 10,00 MW 21,6% % 20,0% % 20,	114,61	\$/MWh	76,12	2 \$/MWh		339,69	\$/MWh		95,48	\$/MWh
23,1% % \$19,35 per KW-Year \$13,10 per KW-Year \$1,50 per KW-Year \$80,00 per MWh 2,0% % 2,0% % 2,0% % 2,0% % 2,0% % 2,0% % 1,30x Ratio 8,0% % 8 760 Hours 1 000 NZD \$870,000 per KW 38 700,000 NZD 000 9% \$2 620,000 NZD 000 9%	OS					Counter				
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						19)	
179.44 \$/M\V/h 129.92 \$/M\V/h 101.24 \$/M\V/h		9%	,	9%			9%			
170,02 \$\pi\text{VINIVVII} 120,02 \pi\text{VINIVVII} 101,24 \pi\text{VINIVVIII}		179,44	\$/MWh	129,92	\$/MWh		101,24	\$/MWh		

Parameters used for each material evaluated for the debt sizing

Pro Forma									
Period	0	1	2	3	26	27	28	29	30
Degradation factor		2,50%	0.60%	0.60%	0.60%	0.60%	0.60%	0.60%	0.6
Electricity Production		17 520	17 520	17 520	17 520	17 520	17 520	17 520	17
Actual electricity production		17082,00	16979,51	16877,63	14695,97	14607,80	14520,15	14433,03	14346
PPA Escalation Factor		1,00	1,02	1,04	1,64	1,67	1,71	1,74	1
nflation Factor		1,00	1,02	1,04	1,64	1,67	1,71	1,74	
PPA Rate		\$80,00	\$81,60	\$83,23	\$131,25	\$133,87	\$136,55	\$139,28	\$14
Electricitiy Revenue		1 367	1 386	1 405	1 929	1 956	1 983	2 010	2
Plus : Cow farming		- (407)	- (400)	-	- (470)	- (470)	- (400)	- (400)	
Less: Operating Expense EBITDA		(107) 1 260	(109) 1 276	(111) 1 293	(176) 1 753	(179) 1 777	(183) 1 800	(186) 1 824	1
Cash Flow Available for Debt Service (CFADS)		1 260	1 276	1 293	1 753	1 777	1 800	1 824	1
Mandatory Debt Service (Sizing) - P50		969	982	995	1 623	1 645	1 667	1 689	1
Mandatory Debt Service (Sizing) - P99		576	584	591	789	799	809	819	
Mandatory Debt Service (Sizing) - Minimum		576	584	591	789	799	809	819	
Beginning Principal		7 319	7 328	7 331	3 223	2 692	2 109	1 469	
Less: Interest Expense		(585)	(586)	(586)	(258)	(215)	(169)	(118)	
Less: Amortization		9	3	(5)	(531)	(583)	(640)	(701)	(
Ending Principal	7 319	7 328	7 331	7 326	2 692	2 109	1 469	768	
otal Debt Service		576	584	591	789	799	809	819	
Actual DSCR		2,19x	2,19x	2,19x	2,22x	2,22x	2,23x	2,23x	2
Equity Cash Flows	(14 081)		693	702	964	978	991	1 005	1
Cumulative Equity Cash Flows Breakeven Year Calculation	(14 081)	(13 398)	(12 705)	(12 003)	5 640	6 617	7 609	8 614	9
	-100,00%	-95,15%	-75,26%	-56,89%	2,49%	2,76%	3,00%	3,22%	3,
Pre-Tax Equity IRR	3,42%								
Equity Breakeven Period		years							
Equity MOIC	1,68x								
Debt WAL	23,15	years							
Equity / debt ratio	192%	years							



https://www.wgtn.ac.nz/sustainable-energy-systems

Sponsor returns with first-lien debt only for the silicon solar cells

Sensitivity analysis											
LPV		Silicon		PSC		CdTe		GaInP		OSC	
Capex +/- 5%											
Change	LCOE	Variation	LCOE	Variation	LCOE	Variation	LCOE	Variation	LCOE	Variation	LCOE
0%	101,2433	0%	114,607	0%	76,118	0%	129,919	0%	339,688	0%	179,442
-5%	96,22397	-5%	108,876	-5%	73,2092	-5%	124,613	-5%	337,505	-5%	174,481
5%	106,2627	5%	120,337	5%	79,0268	5%	135,225	5%	341,871	5%	184,404
	Efficiency +/- 5%										
Change	LCOE	Variation	LCOE	Variation	LCOE	Variation	LCOE	Variation	LCOE	Variation	LCOE
0%	101,2433	0%	114,607	0%	76,118	0%	129,919	0%	339,688	0%	179,442
-5%	106,5719	-5%	120,638	-5%	80,1242	-5%	136,757	-5%	357,567	-5%	188,887
5%	96,42222	5%	109,149	5%	72,4934	5%	123,733	5%	323,513	5%	170,897