

CEEP PV PLANNER[®] OVERVIEW

For over two decades, the Center for Energy and Environmental Policy (CEEP) has investigated the technical and economic feasibility of using solar electric power (provided by commonly termed 'photovoltaic' (PV) technology or 'solar cells'). CEEP has worked with the U.S. National Renewable Energy Laboratory (NREL) and others for 16 years on the development of *PV Planner*[®] software to analyze the benefits of PV technology. *PV Planner*[®] utilizes a vast quantity of data to model the physical, economic, financial and policy contexts specific to the area where the PV system is being installed.

For U.S. applications, *PV Planner*[®] employs the Typical Meteorological Year 3 (TMY3) data set developed at NREL which relies upon over 1,000 weather stations across the U.S. to obtain temperature, insolation and other data relevant to the estimation of PV cell output. The performance of a PV system is reported using several metrics including present value, payback period, benefit-cost ratio, internal rate of return, cash flows and levelized costs. Because policy is constantly developing (particularly with the addition of new incentives to promote renewables), *PV Planner*[®] is regularly upgraded to reflect new policy measures.

CEEP has been able to demonstrate potential savings/benefits of PV systems under different configurations and policy options in several peer-reviewed, published papers, for locations in the U.S. (including Delaware) and abroad. Additionally, CEEP has modeled social and environmental co-benefits from the use of solar-generated electricity, including analyses of policy options to capture these co-benefits. Using *PV Planner*[®], revenue streams from Solar Renewable Energy Credits (SRECs) and other policies (e.g., federal investment tax credit, rebates, the modified accelerated cost recovery system etc.) can be accurately accounted for in the financial analysis of PV system operations.



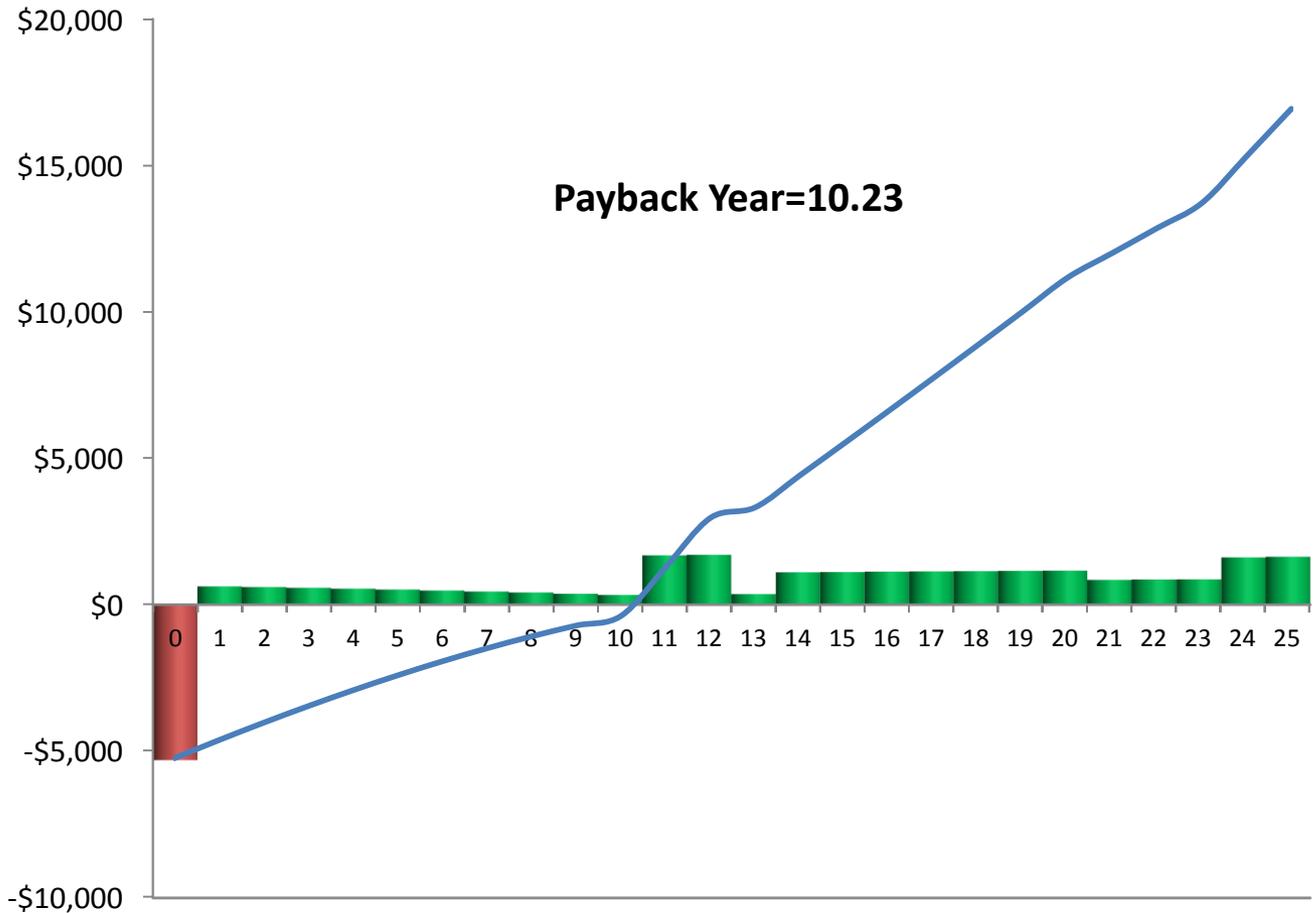
KEY PV PLANNER INPUTS AND RESULTS

	Inputs	Residential [Tier 1]	Commercial [Tier 2]
1	Size of PV Array in kWp	7.5	250
2	Slope of array	25°	10°
3	Array orientation	South	South
4	PV System cost in \$/W _p	6.0	5.0
5	Inverter Replacement year	13	13
6	Annual maintenance and insurance costs in \$	\$175	\$8,375
7	Annual cost escalation rate in % [e.g., for Inflation adjustment]	2%	2%
8	Inverter replacement costs in \$/kW	\$700	\$534
9	Share of loan in the initial capital cost in % (before ITC or TG)	56%	51%
10	Loan Interest rate in %	6%	7%
11	Loan Duration in Years	10	10
12	Combined incremental federal and state tax rate %	33%	40%
13	Evaluation period in years	25	25
14	Transaction costs for Treasury Grant (TG) monetization	0%	10%
15	State or local (e.g., municipal, utility) rebates or grants on initial cost of capital in % or \$/W _p State tax credits if any in %	\$7,131	-
16	Rates (cents/kWh)	14.0	10.5
17	Annual Rate Escalation	2.0%	2.5%
18	Is Income from SRECs taxable?	Yes	Yes
19	SREC price year 10 through 20	\$50	\$50
20	SREC multiplier for instate labor	1.1	1.1
	Results	Residential [Tier 1]	Commercial [Tier 2]
	SREC Price first 10 years (\$/MWh)	\$270	\$250
	Payback Year (for Tier 1)*	10.23	N/A
	IRR in % (for Tier 2)*	N/A	11.69%
	Min. DSCR		1.20

*Following the NREL's methodology (see NREL. 2009. *The Solar Deployment System (SolarDS) Model: Documentation and Sample Results*. page iv), different financial performance metrics were used for different customers. For residential systems, a "time for net positive cumulative cash flow " (payback year) was calculated; for commercial systems, the internal rate of return (IRR) was used.

CEEP PV PLANNER® SELECTED OUTPUTS

Tier 1 (25° tilt): 7.50 kW_p
Initial Yearly Generation: 9.6 MWh



Year	Annual Net Cash Flow	Cumulative Cash Flow
0	(\$5,301)	(\$5,301)
1	\$626	(\$4,676)
2	\$601	(\$4,075)
3	\$574	(\$3,501)
4	\$546	(\$2,955)
5	\$516	(\$2,439)
6	\$484	(\$1,955)
7	\$449	(\$1,506)
8	\$413	(\$1,093)
9	\$374	(\$719)
10	\$332	(\$387)
11	\$1,684	\$1,297
12	\$1,701	\$2,998
13	\$360	\$3,358
14	\$1,106	\$4,464
15	\$1,116	\$5,580
16	\$1,125	\$6,705
16	\$1,135	\$7,840
18	\$1,144	\$8,984
19	\$1,153	\$10,137
20	\$1,161	\$11,298
21	\$849	\$12,147
22	\$858	\$13,005
23	\$867	\$13,872
24	\$1,614	\$15,485
25	\$1,636	\$17,122

* Undiscounted

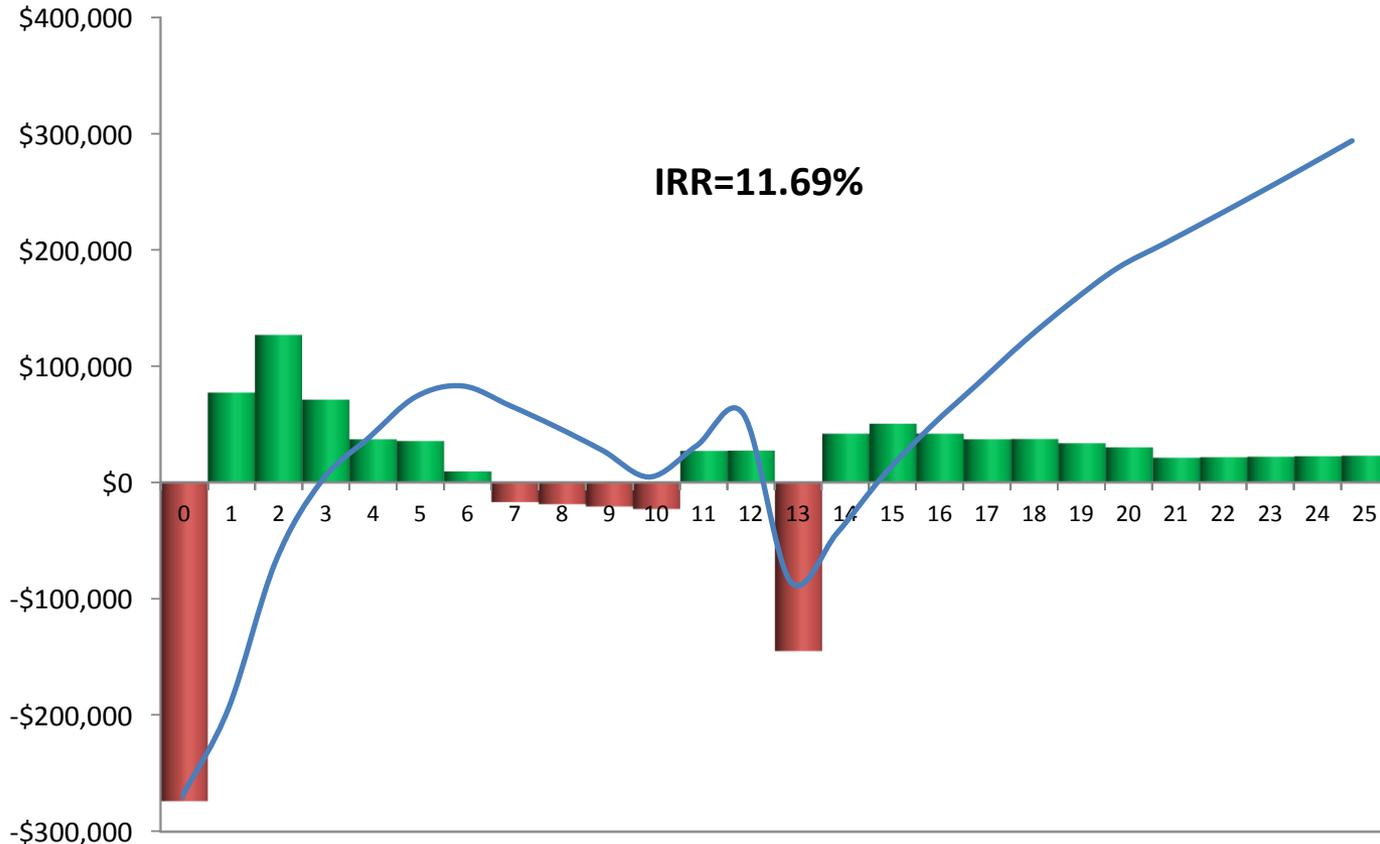


CEEP PV PLANNER[®] SELECTED OUTPUTS

Tier 2 (10° tilt): 250 kW_p
Initial Yearly Generation: 308.5 MWh

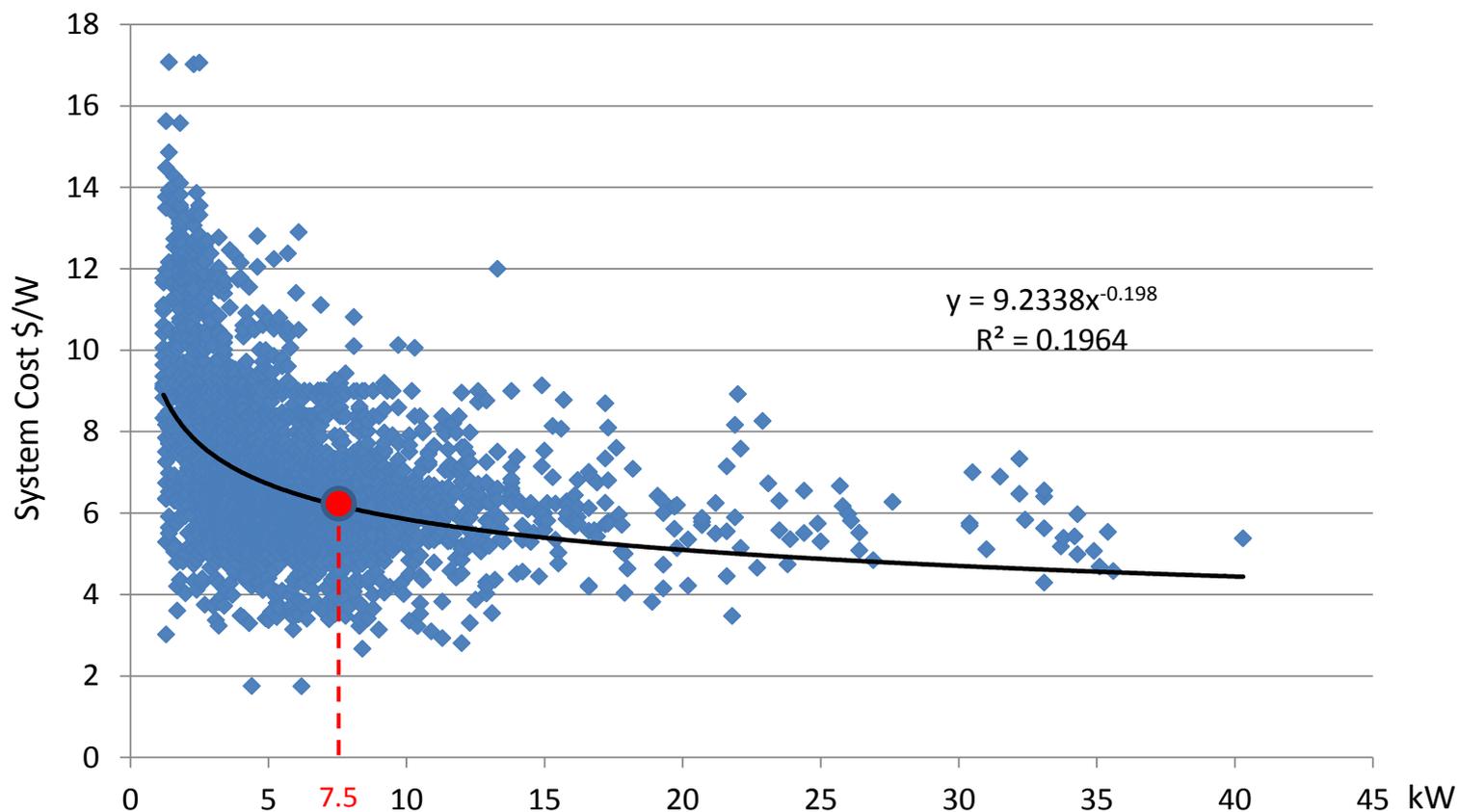
Year	Annual Net Cash Flow	Cumulative Cash Flow
0	(\$273,750.00)	(\$273,750.00)
1	\$77,161.38	(\$196,588.62)
2	\$126,896.18	(\$69,692.44)
3	\$71,147.27	\$1,454.83
4	\$37,068.41	\$38,523.24
5	\$35,532.91	\$74,056.15
6	\$9,413.64	\$83,469.79
7	(\$16,817.07)	\$66,652.72
8	(\$18,687.42)	\$47,965.30
9	(\$20,686.20)	\$27,279.10
10	(\$22,822.79)	\$4,456.31
11	\$27,101.13	\$31,557.44
12	\$27,398.10	\$58,955.54
13	(\$144,994.33)	(\$86,038.79)
14	\$41,829.16	(\$44,209.63)
15	\$50,437.24	\$6,227.61
16	\$41,921.33	\$48,148.94
16	\$36,949.90	\$85,098.84
18	\$37,291.49	\$122,390.33
19	\$33,662.09	\$156,052.42
20	\$30,040.78	\$186,093.20
21	\$21,196.28	\$207,289.48
22	\$21,616.60	\$228,906.08
23	\$22,045.26	\$250,951.34
24	\$22,482.42	\$273,433.76
25	\$22,928.25	\$296,362.01

* Undiscounted



Appendix

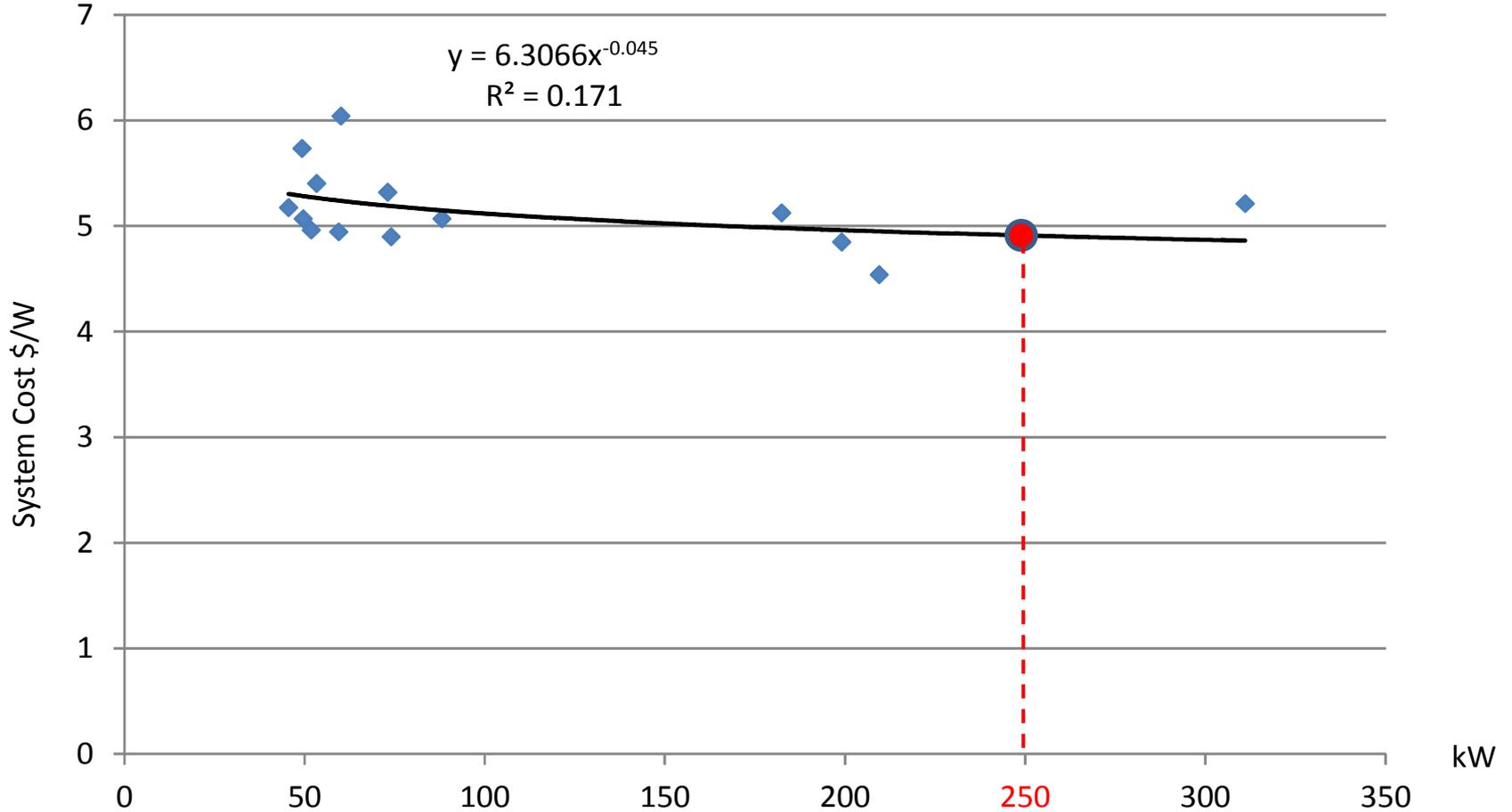
Figure A1. System Cost Data from California
System Size < 50kW (Q4 2010)



Data Source: California Solar Statistics for Q4 2010. <http://www.californiasolarstatistics.ca.gov>



Figure A2. System Cost Data from California
System Size > 50kW (Q4 2010)



Data Source: California Solar Statistics for Q4 2010. <http://www.californiasolarstatistics.ca.gov>



Figure A3. Cost Data from PA Sunshine Solar Program

Costs for all Applications Submitted in January 2011:

	High Cost (\$/Watt)	Median Cost (\$/Watt)	Low Cost (\$/Watt)	Median System Size (kW)
Residential	\$9.86	\$5.97	\$3.13	7.3
Small Business	\$7.00	\$5.51	\$2.67	39.5

Data Source: PA Sunshine Solar Program. 2011.

http://www.portal.state.pa.us/portal/server.pt/community/grants_loans_tax_credits/10395/PA_Sunshine_Solar_Program/821790



Figure A4. Annual O&M and Insurance Costs

Average annual O&M Costs for PV projects is \$19 (2006\$) per kW installed, adjusted for inflation this number is around \$21 per kW in today's \$. [1]

Annual insurance cost is around 0.25% of Installed Project Cost. Insurance Cost might be as high as 0.5% in areas where extreme weather events are likely (e.g., hurricanes in Florida, earthquakes in California, high-winds in Colorado). [2]

Based on these assumptions combined annual O&M and Insurance Costs for 250 kW system = \$8,375 per year

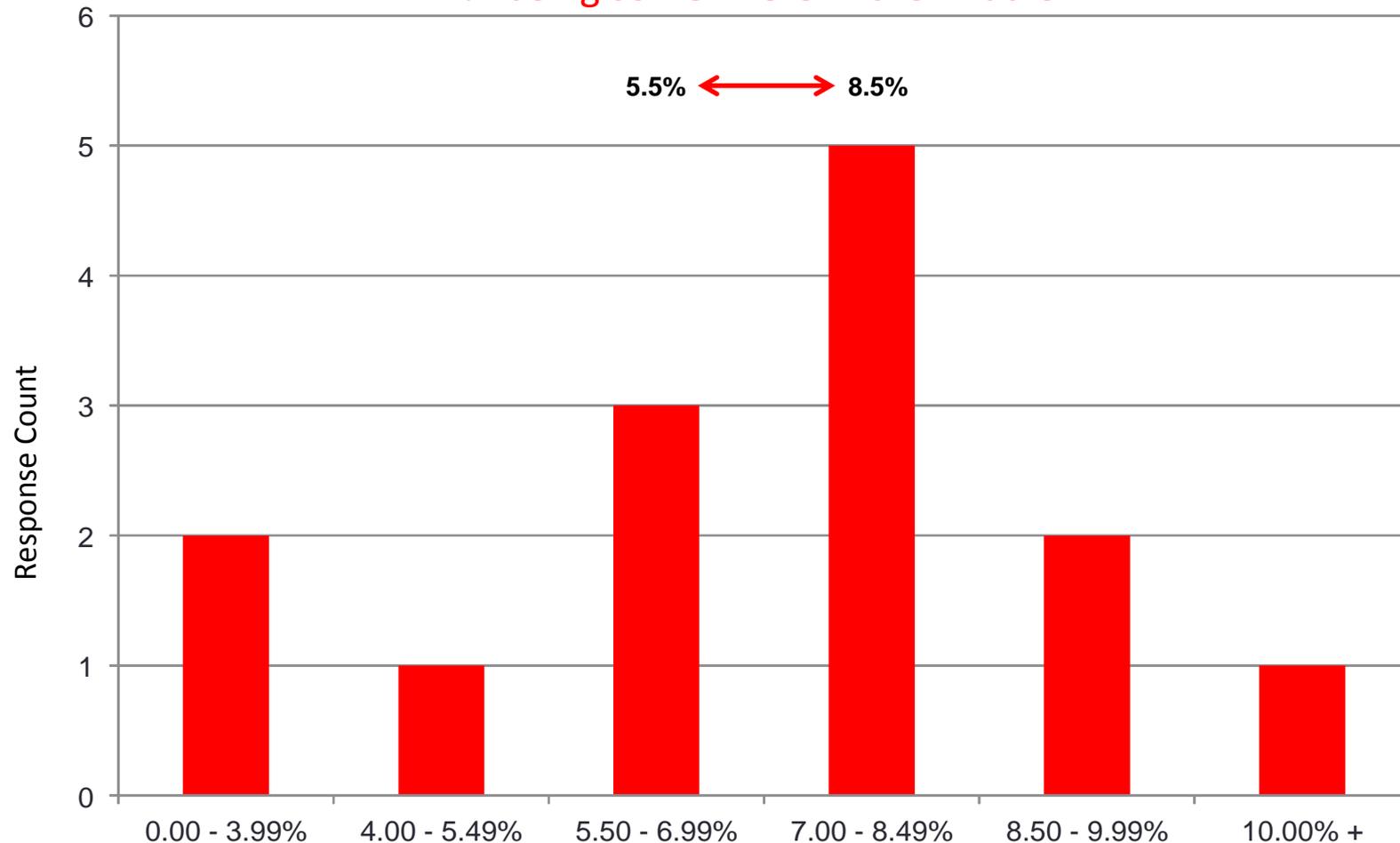
Sources:

[1] NREL, 2011. *Energy Technology Cost and Performance Data*
http://www.nrel.gov/analysis/tech_cost_oandm.html

[2] Speer, B., Mendelsohn, M., and Cory, K. 2010. *Insuring Solar Photovoltaics: Challenges and Possible Solutions*. National Renewable Energy Laboratory (NREL). Technical Report NREL/TP-6A2-46932



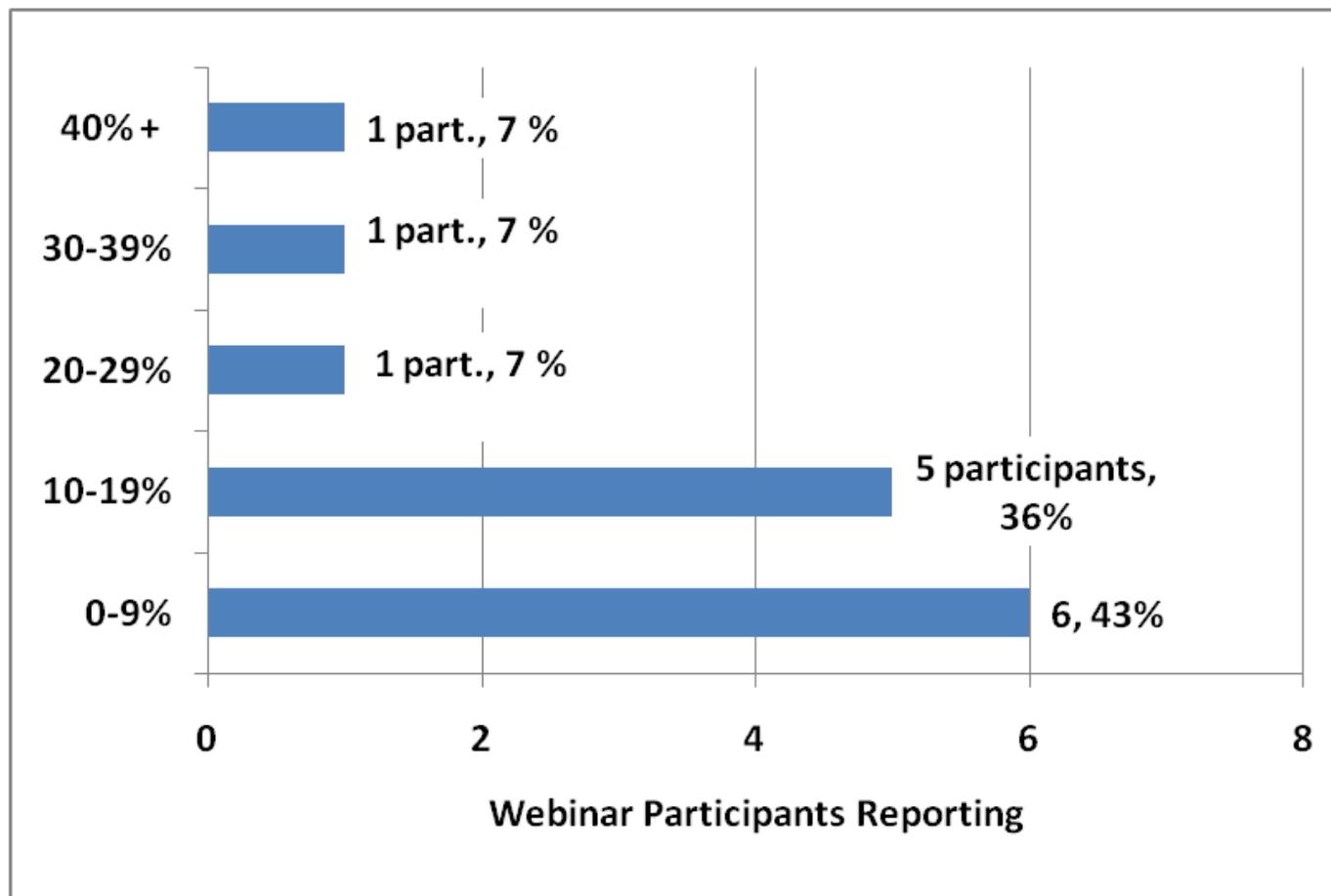
Figure A5. Loan Interest Rate is more likely to be within 5.5% to 8.5%,
7% being somewhere in the middle



Data Sources: NREL Renewable Energy Finance Tracking Initiative (REFTI). Based on Q4 2009, Q1 and Q2 2010 Reports. <http://financere.nrel.gov/finance/REFTI>



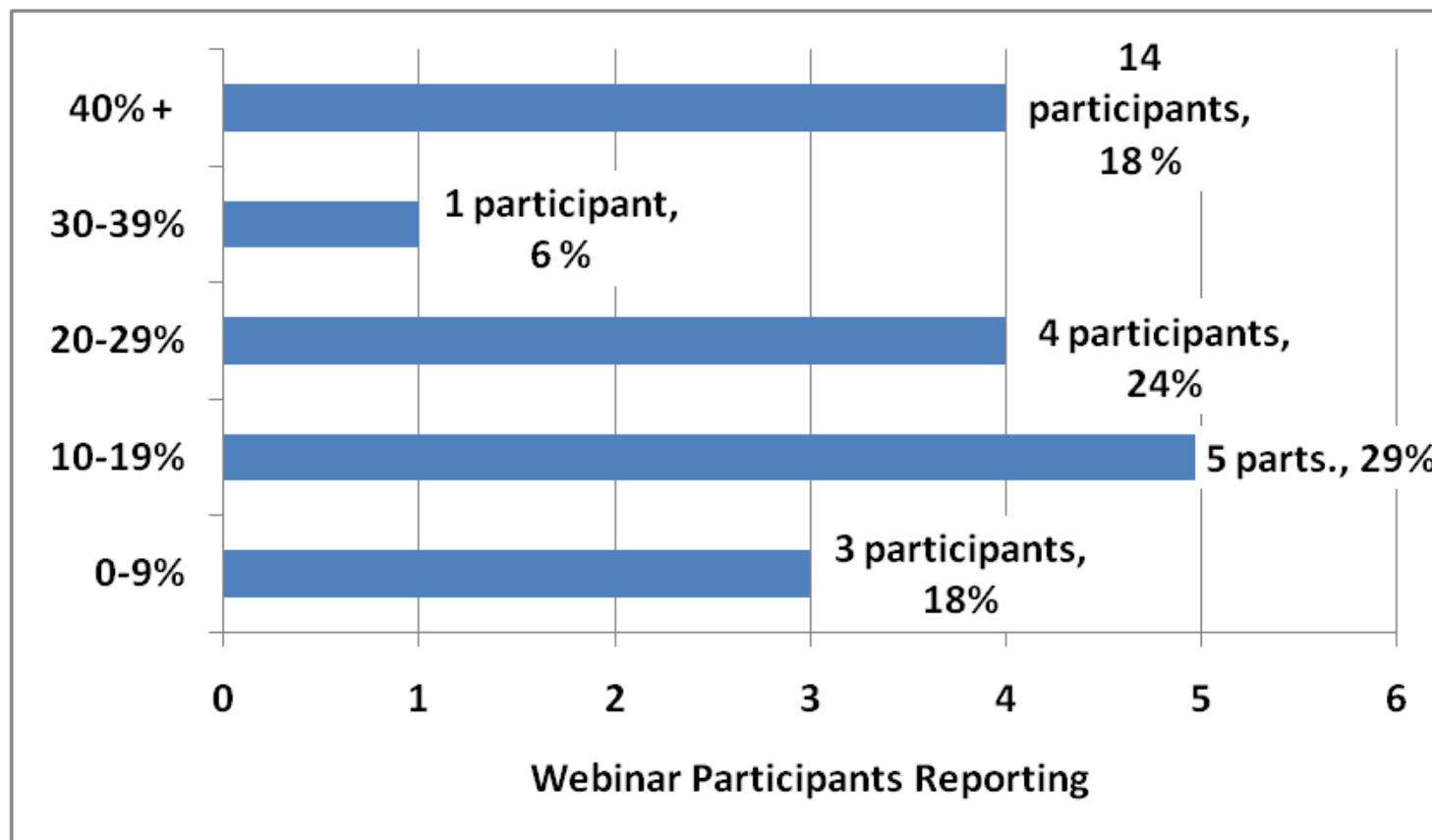
Figure A6. Transaction Costs of Treasury Grant Monetization.
At least 10% need to be allowed for TG monetization



Source: NREL 2010. REFTI Q1 2010 Summer Webinar Poll # 2



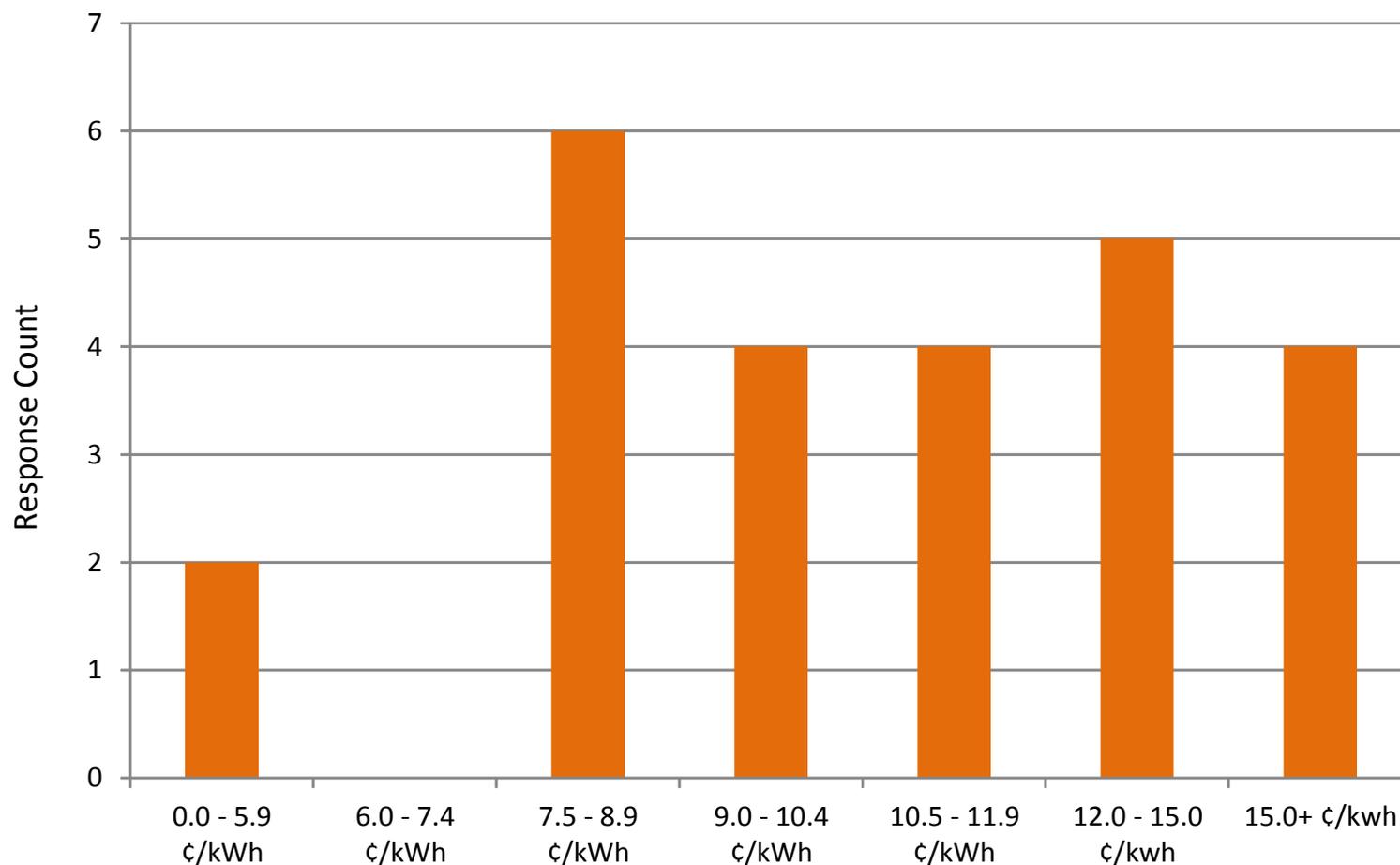
Figure A7. Transaction Costs of Monetizing Tax Credits & MACRS
= 23.8% [weighted average]



Source: NREL 2010. REFTI Q1 2010 Summer Webinar Poll # 3



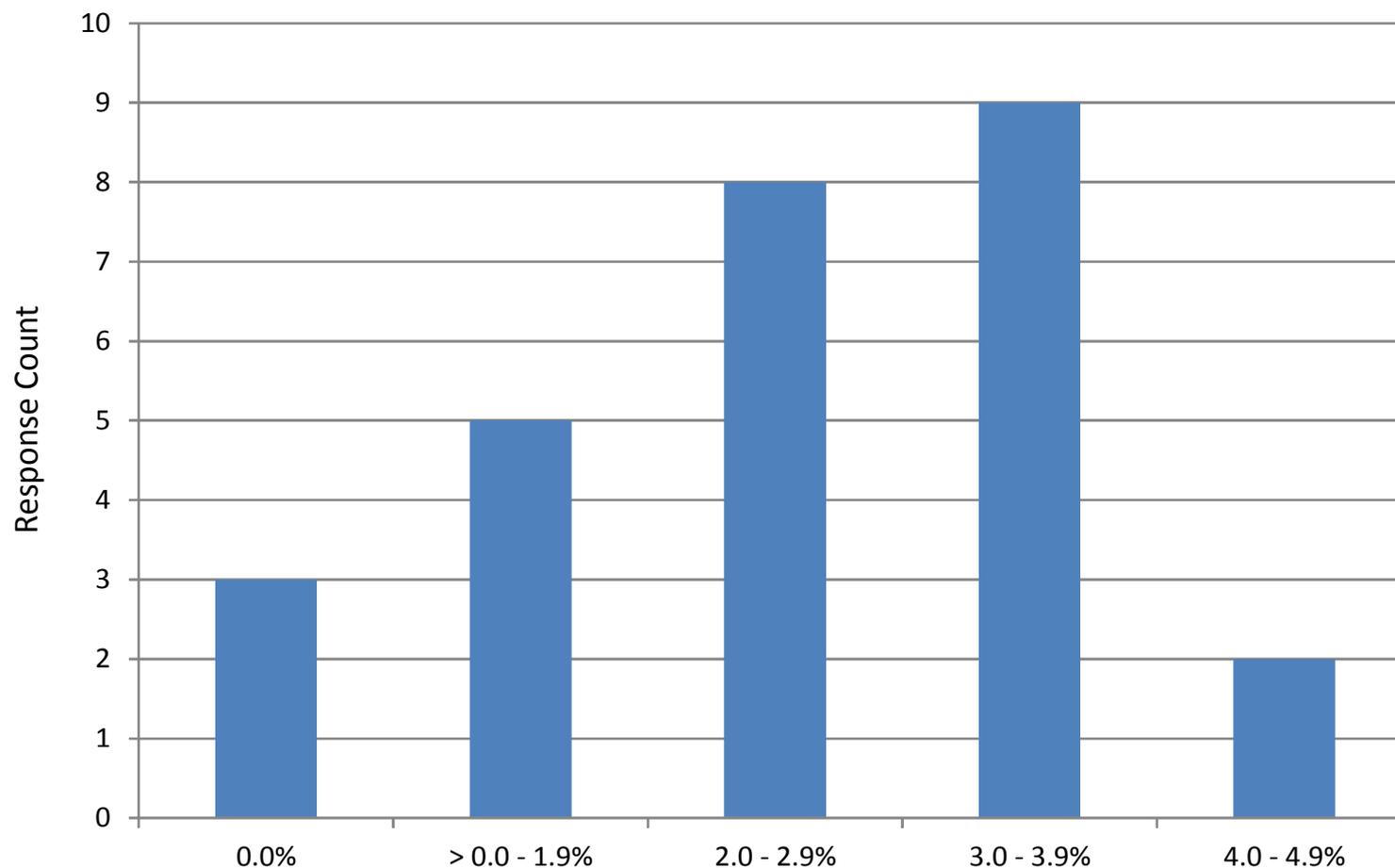
Figure A8. PPA Price for PV Projects under 1 MW in Year 1



Data Sources: NREL Renewable Energy Finance Tracking Initiative (REFTI). Based on Q4 2009, Q1 and Q2 2010 Reports. <http://financere.nrel.gov/finance/REFTI>



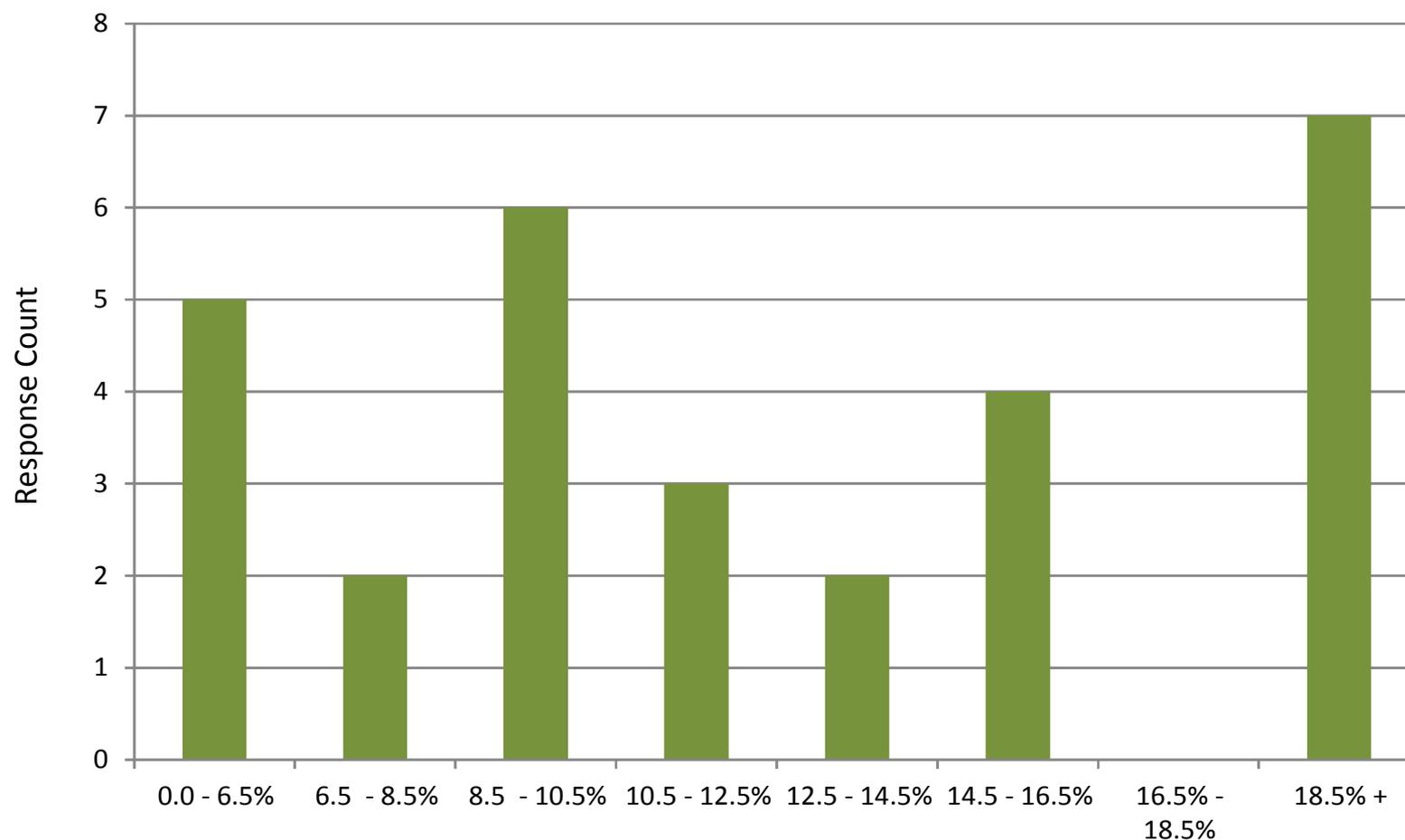
Figure A9. PPA Price Escalation (%) for PV Projects under 1 MW



Data Sources: NREL Renewable Energy Finance Tracking Initiative (REFTI). Based on Q4 2009, Q1 and Q2 2010 Reports. <http://financere.nrel.gov/finance/REFTI>



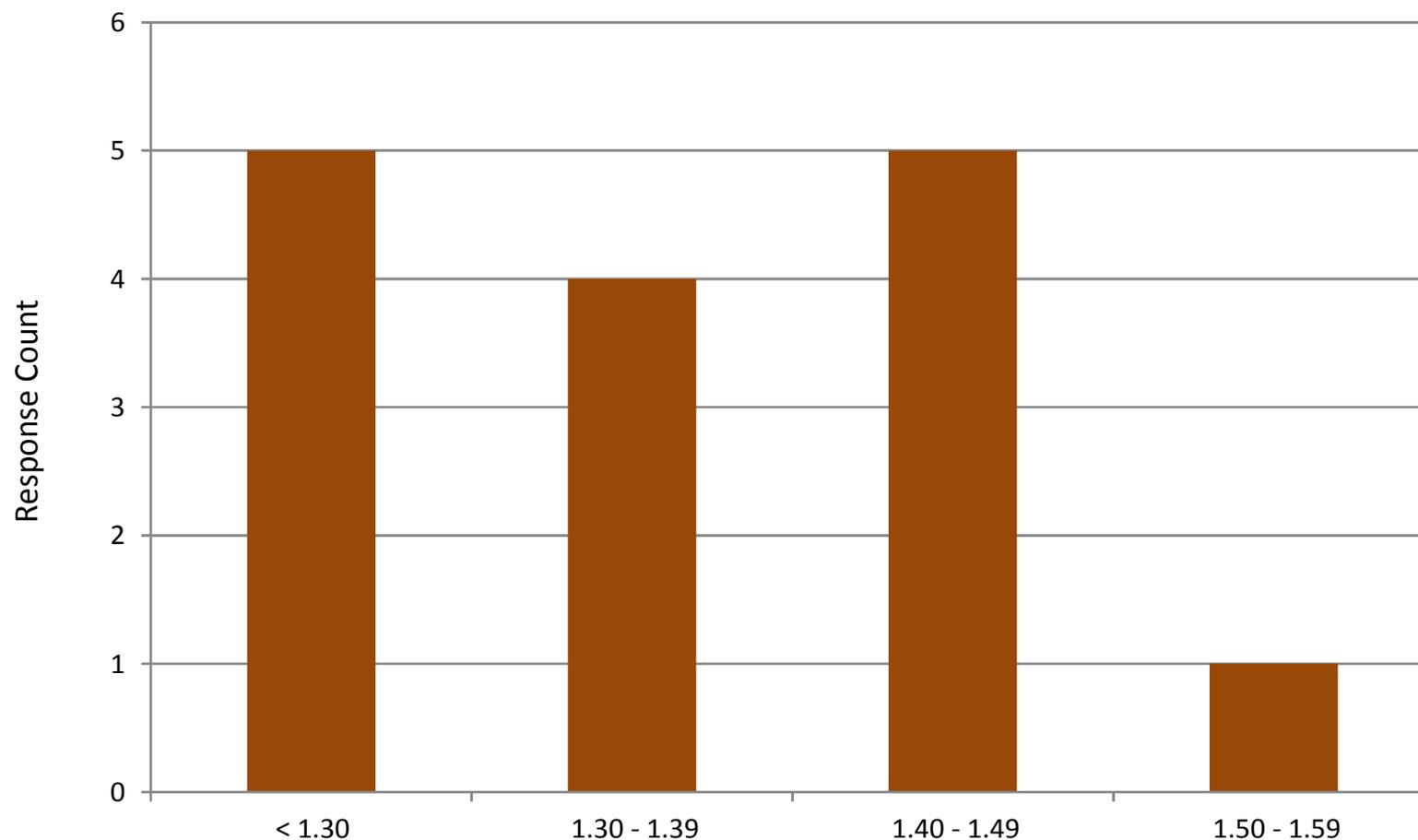
Figure A10. Expected Return on Tax-Investor Equity for PV Projects under 1 MW



Data Sources: NREL Renewable Energy Finance Tracking Initiative (REFTI). Based on Q4 2009, Q1 and Q2 2010 Reports. <http://financere.nrel.gov/finance/REFTI>



Figure A11. Debt Service Coverage Ratio Required for PV Projects under 1 MW



Data Sources: NREL Renewable Energy Finance Tracking Initiative (REFTI). Based on Q4 2009, Q1 and Q2 2010 Reports. <http://financere.nrel.gov/finance/REFTI>

