PV PERFORMANCE GUARANTEES AND 10-YEAR WARRANTIES

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ABSTRACT

Performance guarantees and longer warrantees are proposed as a mechanism for the PV industry to further establish product reliability and create an additional profit source. Conservative performance guarantees could be offered to customers as an assurance to them of limited risk and a guarantee of a reasonable financial return. Such guarantees could be structured to be low risk to the provider and priced such that they are an additional profit center. A guarantee could also boost sales and create additional customer confidence and market differentiators for vendors.

1. INTRODUCTION

Providing optional performance guarantees and longer warrantees is a possible next step for the PV industry to further establish its product as a credible and reliable one that customers can count on to function during and beyond the initial financial payback period.

Some potential customers remain skeptical that the product will last and many more don't yet believe that they will see a financial return on their investment. In order to expand the market, the industry needs to reassure these customers by putting its money where its mouth is.

Conservative performance guarantees could be offered to customers as an assurance to them of limited risk. Such guarantees could be structured to be low risk to the provider and priced such that they are an additional profit center.

There is enough experience with solar electric systems that solid performance predictions can be made based on simulations and estimates.

Inverters have been cited as the weak link in modern PV systems, and few inverter manufactures will provide a warranty beyond 5 years. Because paybacks are typically longer than 5 years, the industry must push forward with more reliable products or financial mechanisms to protect customers' investments. This need will reward manufacturers who can demonstrate higher product reliability.

A performance-based guarantee also pushes the industry forward to focus on performance, not installation capacity. Performance and production are what cleans the air.

2. MECHANICS OF THE GUARANTEE

One guarantee mechanism is to provide a schedule of guaranteed cumulative system output for 5 to 10 years. The customer is paid for each kWh of missed performance, per the schedule.

The payment rate per lost kWh should be less than the value to customer if system works, so the customer is motivated to have the system clean and working, which will provide the best payoff for them. Yet the payment rate should be high enough to provide meaningful protection.

The customer is only paid once for each missed kWh. That is, if there is a shortfall in a year, those lost and paid kWh are subtracted from all future years cumulative guaranteed totals.

In order to provide reasonable estimates for system performance for financial modeling and projections, but still leave some headroom, it is suggested that the guarantee level be 90% of the estimated production level. This will eliminate most of the underperformance due to weather patterns which typically vary +/-9% or less. This will minimize claims and paperwork. See Figure 1 for a sample schedule of guaranteed performance.

End of Year	Module Degradation Loss in Performance	Annual Estimated Production (kWh)	Cumulative Estimated Production (kWh)	Annual Guaranteed Production (90% of Estimated Production) (kWh)	Cumulative Guaranteed Production (kWh)
1	99.5%	16,025	16,025	14,423	14,423
2	99.0%	15,945	31,971	14,351	28,774
3	98.5%	15,866	47,836	14,279	43,053
4	98.0%	15,786	63,623	14,208	57,260
5	97.5%	15,707	79,330	14,137	71,397
6	97.0%	15,629	94,959	14,066	85,463
7	96.6%	15,551	110,510	13,996	99,459
8	96.1%	15,473	125,983	13,926	113,384
9	95.6%	15,396	141,378	13,856	127,240
10	95.1%	15,319	156,697	13,787	141,027

Fig. 1: Sample schedule of guaranteed performance.

2.1 Performance Factors

Good estimation and analysis tools have become available allowing accurate predictions of performance. Factors needing consideration include shading and future shading, orientation, local climate and annual weather variability, excess soiling, and degradation of the modules and the resultant reduction in system performance.

The ability to monitor the systems will speed detection and correction of problems, increasing overall system performance.

2.2 Pricing Factors

The offering should be priced such that is expected to be profitable to the vendor, but reasonable to the consumer. In the examples for this exercise, a 10% price premium over the net cost of the PV system is assumed. Factoring in the cost of repair or replacement of the inverter is likely to be the biggest pricing risk to the vendor. Purchasing extra years of warranty beyond the standard 2 or 5-year manufacturer warranty may help reduce some of the risk to the vendor, but will reduce the net revenue as well.

Inverter manufacturers who will supply solid, independently verified data on expected Mean Time Before Failure (MTBF) may have an competitive marketing advantage, as will those willing to provide extended warrantees.

The cost of additional monitoring, if not sold as a separate premium product, needs to be included in the cost calculations.

2.3 Creating A Reserve Fund

Setting aside some of the revenue from the sales of the guarantee will provide funds to pay for the extra costs associated with maintaining the systems as will be required by the guarantee.

3. LIMITATIONS TO PERFORMANCE GUARANTEES

The guarantee should cover system total cumulative energy production or total production during selected time periods, for example during the peak period of a time-of-use metering schedule. It would be difficult and risky to guarantee a certain maximum annual electric bill because customer usage or electric rate tariffs cannot usually be controlled.

3.1 Risks

Vendors will need to be confident in the performance of their systems, and will need to take into account all the variables mentioned in 2.1 above. There is still a risk of underperformance of the system due to design flaws, installation errors, or poor estimation of performance[1].

There is also the risk of failure of the system or major components. There is a high likelihood that the customer will neglect the system after a period of time, so minimal washing of the PV array should be assumed. There is also the possibility that the customer or other parties could sabotage the system.

Although the "Performance Guarantee" product is expected to be sold at a premium, and on average, should create additional profits for the vendor, there should be a real risk of losing money on the venture. That is to say, if the PV system performs below a certain level, the vendor will pay out more in claims than it took in when selling the "Performance Guarantee" product. By accepting this risk, the vendor provides real value and protection to the customer. See Figure 5 for an example of substantial losses.

Not all risks to investing in a solar system are mitigated by a performance guarantee. Other risks such as utility tariff changes, tax benefits, etc, are not covered.

3.2 Methods of Mitigating Risks

Internet enabled monitoring solutions are now available for real-time tracking of system performance, and in some cases, remote diagnosis of failures. This will speed detection and correction of problems, limiting downside risk to the guarantor.

If the guarantee is designed as a function of lifetime cumulative performance, the risk due to weather is largest in the first year. Statistical weather patterns average out over a few years, reducing weather risk. If there is systematic underperformance unrelated to the weather, after the first few years, averaging of the weather offsets some of non-weather losses in performance.

Using reasonable but conservative estimates of performance (ie. not overselling the performance), will reduce the likelihood of multiple factors conspiring to create a significant claim situation.

10.0	kW AC CEC of system
16,106	kWh First Year Estimated Production
99.5%	Module Degradation Factor
94%	Additional Dirt Loss Factor (if Customer Never Washes System)
90%	Guaranteed Production % of estimated production
10%	Percent Price Adder for Guarantee
$ 5,700	Extra Revenue from 10% Price Adder (after rebate price)
$0.25	Compensation per lost kWh

Fig. 2: Variables and Simulation Inputs

4. EXAMPLES

Figure 2 shows the input variables to a simulation that assumes realistic system performance, modified by a 94% additional soiling factor (some soiling was already assumed) if the system is never washed and is in a somewhat dusty area. In agricultural areas, soiling has been reported to be much more severe.

Figure 3 shows an example with no additional performance losses. This would be the ideal case assuming average weather. Notice that the Cumulative Shortfall is negative, so in effect, a buffer against future losses has been stored up. This would need to be used up by future losses before any liability would be incurred.

Figure 4 shows a case where the system systematically

End of Year	Additional Random Loss Factor	Annual Actual Production (kWh)	Annual Shortfall (kWh)	Cumulative Actual Production (kWh)	Cumulative Shortfall (kWh)	Net kWh Owed	Annual Payout ($)	Cumulative Payout ($)	Net Profit Remaining ($)
1	100%	15,064	-641	15,064	-641	0	$ -	$ -	$ 5,700
2	100%	14,989	-638	30,053	-1,279	0	$ -	$ -	$ 5,700
3	100%	14,914	-635	44,966	-1,913	0	$ -	$ -	$ 5,700
4	100%	14,839	-631	59,805	-2,545	0	$ -	$ -	$ 5,700
5	100%	14,765	-628	74,570	-3,173	0	$ -	$ -	$ 5,700
6	100%	14,691	-625	89,261	-3,798	0	$ -	$ -	$ 5,700
7	100%	14,618	-622	103,879	-4,420	0	$ -	$ -	$ 5,700
8	100%	14,545	-619	118,424	-5,039	0	$ -	$ -	$ 5,700
9	100%	14,472	-616	132,895	-5,655	0	$ -	$ -	$ 5,700
10	100%	14,399	-613	147,295	-6,268	0	$ -	$ -	$ 5,700

Fig. 3: Example With No Performance Loss Showing Surpluses and No Financial Losses.

End of Year	Additional Random Loss Factor	Annual Actual Production (kWh)	Annual Shortfall (kWh)	Cumulative Actual Production (kWh)	Cumulative Shortfall (kWh)	Net kWh Owed	Annual Payout ($)	Cumulative Payout ($)	Net Profit Remaining ($)
1	80%	12,051	2,372	12,051	2,372	2,372	$ 593	$ 593	$ 5,107
2	80%	11,991	2,360	24,042	4,732	2,360	$ 590	$ 1,183	$ 4,517
3	80%	11,931	2,348	35,973	7,080	2,348	$ 587	$ 1,770	$ 3,930
4	80%	11,871	2,336	47,844	9,416	2,336	$ 584	$ 2,354	$ 3,346
5	80%	11,812	2,325	59,656	11,741	2,325	$ 581	$ 2,935	$ 2,765
6	80%	11,753	2,313	71,409	14,054	2,313	$ 578	$ 3,513	$ 2,187
7	80%	11,694	2,302	83,103	16,355	2,302	$ 575	$ 4,089	$ 1,611
8	80%	11,636	2,290	94,739	18,645	2,290	$ 572	$ 4,661	$ 1,039
9	80%	11,577	2,279	106,316	20,924	2,279	$ 570	$ 5,231	$ 469
10	80%	11,520	2,267	117,836	23,191	2,267	$ 567	$ 5,798	$ (98)

Fig. 4: Example With Consistent Systematic Performance Losses Showing Break Even.

underperforms, perhaps due to an error in design, estimation of output, or a consistently failed component or wiring. Even with an additional 20% of unexpected losses, and an extra 6% dirt loss, this system will break even for the vendor over 10 years.

Figure 5 shows the worst-case scenario – total system failure to perform. In this case, the losses to the vendor quickly mount to a net total loss of about $30,000. This is quite a bit less than the customer paid for the system, but would still be very expensive for the vendor, so they would be highly motivated to fix the system.

It would be in the customer's interest to have the system fixed as well, as they are not getting anything out of their investment except warranty claims, which are falling short of their expenses.

Figure 6 and Figure 7 show the difference in financial consequence of a complete year of lost performance depending on when it occurs. If it happens in Year 1, as in Figure 6, the cost is fairly high, If it occurs in Year 9 as in Figure 7, the cost is greatly diminished, because of the accumulated credits for the years that there was a net surplus.

End of Year	Additional Random Loss Factor	Annual Actual Production (kWh)	Annual Shortfall (kWh)	Cumulative Actual Production (kWh)	Cumulative Shortfall (kWh)	Net kWh Owed	Annual Payout ($)	Cumulative Payout ($)	Net Profit Remaining ($)
1	0%	0	14,423	0	14,423	14,423	$ 3,606	$ 3,606	$ 2,094
2	0%	0	14,351	0	28,774	14,351	$ 3,588	$ 7,193	$ (1,493)
3	0%	0	14,279	0	43,053	14,279	$ 3,570	$ 10,763	$ (5,063)
4	0%	0	14,208	0	57,260	14,208	$ 3,552	$ 14,315	$ (8,615)
5	0%	0	14,137	0	71,397	14,137	$ 3,534	$ 17,849	$ (12,149)
6	0%	0	14,066	0	85,463	14,066	$ 3,516	$ 21,366	$ (15,666)
7	0%	0	13,996	0	99,459	13,996	$ 3,499	$ 24,865	$ (19,165)
8	0%	0	13,926	0	113,384	13,926	$ 3,481	$ 28,346	$ (22,646)
9	0%	0	13,856	0	127,240	13,856	$ 3,464	$ 31,810	$ (26,110)
10	0%	0	13,787	0	141,027	13,787	$ 3,447	$ 35,257	$ (29,557)

Fig. 5: Worst Case Example With 100% Loss Showing Maximum Financial Losses.

End of Year	Additional Random Loss Factor	Annual Actual Production (kWh)	Annual Shortfall (kWh)	Cumulative Actual Production (kWh)	Cumulative Shortfall (kWh)	Net kWh Owed	Annual Payout ($)	Cumulative Payout ($)	Net Profit Remaining ($)
1	0%	0	14,423	0	14,423	14,423	$ 3,606	$ 3,606	$ 2,094
2	100%	14,989	-638	14,989	13,785	0	$ -	$ 3,606	$ 2,094
3	100%	14,914	-635	29,902	13,150	0	$ -	$ 3,606	$ 2,094
4	100%	14,839	-631	44,741	12,519	0	$ -	$ 3,606	$ 2,094
5	100%	14,765	-628	59,506	11,891	0	$ -	$ 3,606	$ 2,094
6	100%	14,691	-625	74,197	11,266	0	$ -	$ 3,606	$ 2,094
7	100%	14,618	-622	88,815	10,644	0	$ -	$ 3,606	$ 2,094
8	100%	14,545	-619	103,360	10,025	0	$ -	$ 3,606	$ 2,094
9	100%	14,472	-616	117,831	9,409	0	$ -	$ 3,606	$ 2,094
10	100%	14,399	-613	132,231	8,796	0	$ -	$ 3,606	$ 2,094

Fig. 6: Example With 100% Performance Losses in Year 1.

End of Year	Additional Random Loss Factor	Annual Actual Production (kWh)	Annual Shortfall (kWh)	Cumulative Actual Production (kWh)	Cumulative Shortfall (kWh)	Net kWh Owed	Annual Payout ($)	Cumulative Payout ($)	Net Profit Remaining ($)
1	100%	15,064	-641	15,064	-641	0	$ -	$ -	$ 5,700
2	100%	14,989	-638	30,053	-1,279	0	$ -	$ -	$ 5,700
3	100%	14,914	-635	44,966	-1,913	0	$ -	$ -	$ 5,700
4	100%	14,839	-631	59,805	-2,545	0	$ -	$ -	$ 5,700
5	100%	14,765	-628	74,570	-3,173	0	$ -	$ -	$ 5,700
6	100%	14,691	-625	89,261	-3,798	0	$ -	$ -	$ 5,700
7	100%	14,618	-622	103,879	-4,420	0	$ -	$ -	$ 5,700
8	100%	14,545	-619	118,424	-5,039	0	$ -	$ -	$ 5,700
9	0%	0	13,856	118,424	8,817	8,817	$ 2,204	$ 2,204	$ 3,496
10	100%	14,399	-613	132,823	8,204	0	$ -	$ 2,204	$ 3,496

Fig. 7: Example With 100% Performance Losses in Year 9 for comparison to Figure 6.

End of Year	Additional Random Loss Factor	Annual Actual Production (kWh)	Annual Shortfall (kWh)	Cumulative Actual Production (kWh)	Cumulative Shortfall (kWh)	Net kWh Owed	Annual Payout ($)	Cumulative Payout ($)	Net Profit Remaining ($)
1	80%	12,051	2,372	12,051	2,372	2,372	$ 593	$ 593	$ 5,107
2	90%	13,490	861	25,541	3,233	861	$ 215	$ 808	$ 4,892
3	100%	14,914	-635	40,455	2,598	0	$ -	$ 808	$ 4,892
4	80%	11,871	2,336	52,326	4,935	1,702	$ 425	$ 1,234	$ 4,466
5	90%	13,288	848	65,614	5,783	848	$ 212	$ 1,446	$ 4,254
6	100%	14,691	-625	80,305	5,158	0	$ -	$ 1,446	$ 4,254
7	90%	13,156	840	93,461	5,997	215	$ 54	$ 1,499	$ 4,201
8	50%	7,272	6,653	100,734	12,651	6,653	$ 1,663	$ 3,163	$ 2,537
9	100%	14,472	-616	115,205	12,035	0	$ -	$ 3,163	$ 2,537
10	90%	12,960	827	128,165	12,862	211	$ 53	$ 3,216	$ 2,484

Fig. 8: Example With Random Performance Losses Showing Net Profit

If the additional losses due to extra soiling are less, then this factor is even more beneficial, and the difference will be even greater.

The final example is Figure 8 showing a random sampling of performance losses. It is hoped that these simulated losses would be larger than anything that would normally be encountered. Even if the losses were this big, a total of $3,216 would be paid out over 10 years. The guarantee would still be profitable by almost $2,500 for the vendor.

If properly priced, and risk is accounted for, even payouts for extreme weather can result in profitable operation.

5. TEN-YEAR WARRANTEES

Another premium option is the 10-year warranty. Current California solar systems getting a CEC (California Energy Commission) rebate are required to have a 5-year warranty. A market leading company could offer a 10-year warranty as a sales incentive, possibly at a premium. Initially offered as an option, when competitors take it up, it could become a standard feature of the leader's systems.

5.1 Risks to Extended Warranties

The risks to offering an extended warranty include the cost of parts and labor to ensure the PV system is functional for 10 years. If the inverter manufacturer goes out of business, then any warranty they provided is useless. Worse, if the system voltage range doesn't match the available replacements, the system may have to be redesigned and rewired. Some protection might be afforded the installer if the inverter warranty is a pass-thru warranty, rather than a complete system warranty, although that reduces the benefit to the customer.

If the roof leaks, the installer may be responsible for repair of the leak and any damage, including mold. Mold could pose very serious liability concerns.

It will be important to consider the differences between full and limited warrantees. A limited warranty may dramatically reduce the seller's risks, without greatly diminishing the marketing value of making the offer. There may be federal, state and other laws that apply to making such warrantees.

Each other risk present in the vendor's current system warranty must be examined for its expected cost for each additional year added to the warranty. Some inverter manufactures offer extended warrantees, at an additional cost, that might help mitigate some of the vendor's risk.

6. BENEFITS

There are significant benefits of both Extended Warrantees and Performance Guarantees to both the installer and the end customer.

6.1 Benefits To The Seller

A direct benefit is the premium for which such an option can be sold. It could add 5 to 15% to the revenue from a sale. Some of this revenue should be set aside as a Reserve Fund, but the rest becomes additional profit. In all cases, the extra revenue can become extra working capital that won't need to be paid out for several years until a claim is made. Having use of this money in a capital intensive business could be a big advantage.

It should also open the market to more customers, those who are less confident about system performance. For 10% more, the customer can reduce the risk of owning a new technology, while still reaping its benefits.

There are marketing advantages as well. The guarantee allows the seller to differentiate from the competition, thereby increasing sales. Even if the customer doesn't choose the option, they know the seller has a strong belief that the product will perform as advertised, and is willing to take a financial stake in the performance. It may help the customer chose one company over another, even if they choose not to pay the premium for the extra assurance.

It can also help create a marketing buzz, something to talk about, announce, send out a press release, etc. It provides another reason to make news.

6.2 Benefits To The Buyer

To the customer, the product offers assurance, security and comfort in making an expensive purchase. The guarantee takes much of the risk out of a solar investment, making it safer.

Making the investment safer entitles the investing customer to a lower rate of return on the investment (lower risk generally begets lower returns), which is the net result of paying more for the system including the premium for the guarantee. However, because they will be getting essentially a guaranteed return, it may be an even more attractive investment.

The reduction in the Rate of Return is roughly proportional to the additional net cost of the performance guarantee. If the guarantee adds 10% to the cost of the system, the Rate of Return drops by about 10% (ie. drops from 14% to 12.6%)[2]. However, this is effectively a guaranteed yield. From this perspective, it may be possible to charge more for the performance guarantee.

CONCLUSION

Properly estimated and priced, a guarantee mechanism will reassure customers and provide profits to vendors. It provides motivation to both the seller and their competitors to provide high quality system design and installation. Sellers will demand better and more reliable system components from their suppliers as well.

RECOMMENDATIONS

The performance guarantee and extended warranty add cost to the system, making the purchase barrier larger. At least initially they could be considered optional add-ons, so that a consumer is free to choose, if they see value in it.

Performance Based Incentives (PBIs) will increase the value of a guarantee offering to a customer. If PBIs proliferate, getting maximum performance will become even more important for a customer seeking a good return on their investment.

Similarly, Tradable Renewable Certificates (TRCs) will add further emphasis to the value of system performance. Adjusting the cost and payout to these changing market conditions may be relevant to market acceptance and mutual benefit.

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