Salvage Values Determines Reliability of Used Photovoltaics

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ABSTRACT

Tracking salvage values can help to represent the reliability of a particular technology, the manufacturer and model of PV modules. There exists a secondary market for used modules and new modules from bankrupt companies. This presentation examines data from historic utility salvage sales and a bankruptcy auction. Reliability perspectives are presented. From 2005 to 2012, large volume of used PV modules sold at salvage for a variety of pricing dependent upon age, strength of glass, amount of easily recycled aluminum, industry reduced average selling price (ASP) of new modules and expectations for future energy production. Reliability of product, both real and perceived, are important factors in resale valuations.

Photo 1: 2006 Stacked single crystal silicon salvaged PV.

LARGE SCALE SALVAGE SALES

The Sacramento Municipal Utility District (SMUD) has been re-selling salvaged PV equipment since 2005. The table presented includes the technology based dollar per nameplate watt prices. 1 MW of nameplate modules were sold during this period.

Winning bids ranged from $0.04 to $1.26 / watt. The table shows minimum, maximum, average $/watt winning price for individual lots and approximate nameplate wattage sold that year. Modules sold included tandem amorphous silicon (a-Si), single crystal (Single) and polycrystal (Poly) PV. Model numbers included: Solarex MST 43 and MSX 60, Shell SQ 75/80, Solec SP-102 and SQ-80, and Siemens M55's. Some modules had been panelized, as shown in Photo 1. Graph 1 shows these trends overtime.

New Abound Solar CdTe Modules sold between $0.77 and $0.38/watt during the 2012 bankruptcy auction (see Photo 2 & 3). 50 modules per crate sold at different prices due to higher wattage and larger quantity of crates.

Winning Bids from 7 Years of Surplus Photovoltaic Sales at SMUD

	2005		2006		2007		2008		2009		2010		2012	
Bid Lot	Type	Price Per watt	Type	Price Per watt	Type	Price Per watt	Type	Price Per watt	Type	Price Per watt	Type	Price Per watt	Type	Price Per watt
1	a-Si	$0.46	a-Si	$0.46	Single	$0.78	a-Si	$0.53	a-Si	$0.07	a-Si	$0.09	a-Si	$0.21
2	a-Si	$0.46	a-Si	$0.31	Single	$0.66	a-Si	$0.50	a-Si	$0.06	a-Si	$0.13	a-Si	$0.25
3	a-Si	$0.46	a-Si	$0.20	Single	$0.77	a-Si	$0.97	a-Si	$0.04	a-Si	$0.07	a-Si	$0.22
4	Poly	$0.98	a-Si	$0.22	Single	$0.82	Poly	$0.44	a-Si	$0.06	Poly	$0.23	Single	$0.27
5	Poly	$0.75	a-Si	$0.24	Single	$0.73	Poly	$1.15	a-Si	$0.04	Single	$0.13	Single	$0.20
6	Single	$0.51	Single	$0.66	Single	$0.82	Single	$0.54	a-Si	$0.04	Single	$0.13	Single	$0.27
7	Single	$0.51	Single	$1.04	Single	$0.72	Single	$0.83	Poly	$0.17	Single	$0.18		
8	Single	$0.61	Single	$1.26	Single	$0.48	Single	$0.88	Poly	$0.48	Single	$0.19		
9	Single	$0.61	Single	$0.77	Single	$0.66	Single	$0.76	Poly	$0.24	Single	$0.33		
10	Single	$0.61	Single	$0.77	Single	$0.82	Single	$0.88	Poly	$0.29	Single	$0.04		
11			Single	$0.92	Single	$0.78	Single	$0.91	Poly	$0.21	Single	$0.24		
12					Single	$0.82	Single	$0.72	Poly	$0.17				
13					Single	$0.52	Single	$0.56	Poly	$0.23				
14							Single	$0.72	Single	$0.25				
15							Single	$0.65	Single	$0.24				
16									Single	$0.17				
17									Single	$0.30				
18									Single	$0.16				
Min		$0.46		$0.20		$0.48		$0.44		$0.04		$0.04		$0.20
Max		$0.98		$1.26		$0.82		$1.15		$0.48		$0.33		$0.27
Total kW	150		69		177		136		212		160		75	

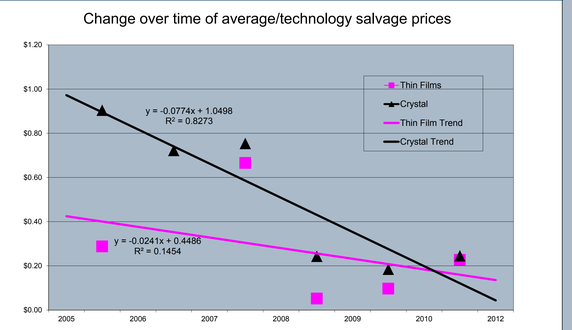
Table 1: 2005 – 2012 Salvage Values for various technologies; 1 MW total original capacity.

RESALE MARKETS

Used modules are bought and sold in a number of ways. They can be installed into non-incentivized systems like off grid markets. They are often sold in resale channels like on E-Bay, Craigslist or classified section of Home Power Magazine.

Individual modules could be sold into existing systems where a component has broken. If an existing PV system has a problem with an individual module, replacing that module could have a very high system level value.

Scrap markets can utilize crystalline cells, as well as the aluminum frames, thus non-working crystalline modules can have an attractive scrap value. Various PV recycling programs are available around the world including a PV ReCycling.



Graph 1: Trends for salvage sales, 2005 to 2012.)

Photo 2 & 3: Crate of 50 new Abound CdTe ($0.77 to $0.38/W) & 800 to 2000 lbs. of broken CdTe. Were 140,000 of these CdTe modules locally landfilled?

ENERGY, GLASS

Most PV technologies lose 1% per year in performance consistent with typical 20 year, 80% power warranties. A module with an original standard test condition (STC) power output rating of 100 watts will probably be producing 90 watts at STC after ten years, 80 watts after 20 years. Used modules can be tested for their performance using a max power point current / voltage meter, correcting for module temperature and actual solar radiation normalized to the STC conditions of 1,000 W/m^2.

SMUD salvage sales illustrates a-Si on breakable float glass has considerable less salvage value than single or poly silicon technologies using tempered glass. Visual factors including browning of EVA was an important factor for resale, with large amounts of browning, as shown in the 15 year old single crystals cells of Photo 5, reducing the resale value dramatically.

PHOTOS OF SALVAGED PV MODULES

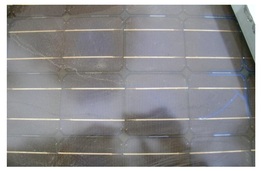


Photo 4 & 5: 1995 Solec SP-102's piled up in 2010, EVA discoloration, lowered price, but didn't effect performance.

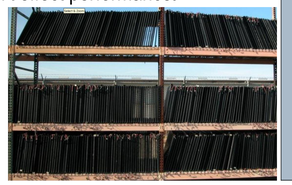


Photo 5 & 6: Well stacked float glass a-Si for bid in 2009.

PHOTOS OF SALVAGED PV MODULES

Photo 7: Well cared for and stacked modules obtain best salvage price.

Photo 8: Panorama of poorly handled float glass a-Si for bid 2005.

2011 Salvage Operation

In 2011 we examined the 144 Solec SP-102's 24 volt modules shown in photo #4 for the actual resale value. Operating modules produced approximately 85 watts in full sun, consistent with a 1%/year degradation. Performance was field measured with a 100 watt variable resistor providing voltage open circuit, short circuit current and a good approximation of voltage and current at max power in full sunlight. Good modules with junction boxes sold on a roadside in Grass Valley CA (see Photo 9) for between $30 and $50 each. Modules without junction boxes sold in bulk for $20 each. Approximately 15% of the modules were discarded because of glass breakage (see Photo 10), delamination, serious browning of EVA (see Photo 5), obvious burn marks on interconnections or damaged backsheets. Angle aluminum used to panelize the modules was salvaged at a high value. The time needed to transport, warehouse, clean, examine, sort, inventory, and sell the surplus modules considerably reduced the value of the salvage operation. Ideally modules would be taken out of service with immediate installation in a new location.

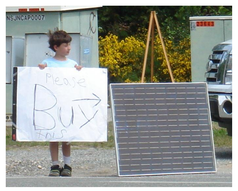


Photo 9 & 10: Selling PV in CA, Broken and good quality modules.

CONCLUSION

There is a healthy resale market for PV modules that should be recognized in project level economic calculations. The salvage price is a market reflection of the reliability. Functioning modules will have a revenue value based on life/performance expectations with the additional shipping and handling costs in comparison to other alternative to electric generation costs. The fragility due to glass used in PV modules has important resale value ramifications. Live auction might provide higher salvage values as in the Abound Solar experience. There exists a healthy used PV module market. Safety and performance standards for used modules will become more important as salvaged modules show up in greater numbers in future years. Recycling is an important industry issue.

ACKNOWLEDGMENTS / REFERENCES

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Personal Communication, On-going, Jennifer Woolwich.

SMUD Salvage Sales, 2005 – 2012 http://www.smud.org

NREL PVRW 2010 BP Solar presentation pvrw2010_wohlgemuth.pdf

October 2012 Abound Solar Bankruptcy auction.

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