The Value of Vigilance: Evaluating Product Quality in the Kenyan Solar Photovoltaics Industry

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The solar market in Kenya is among the largest and most dynamic per capita among developing countries. Cumulative solar sales in Kenya since the mid-1980s are estimated to be in excess of 200,000 systems, and annual sales growth has regularly topped 15% over the past decade [Jacobson, 2004]. Much of this activity is related to the sale of household solar electric systems, which account for an estimated 75% of solar equipment sales in the country [ESDA, 2003].

Despite this undisputed commercial success, product quality continues to be an important concern in the Kenya market. The primary results presented in this report are based on tests of five different brands of amorphous silicon (a-Si) solar modules sold in Kenya. These tests were carried out at Humboldt State University (HSU) and the University of California at Berkeley (UCB) between September of 2004 and March of 2005. The results of these tests indicate that while three of the five brands of a-Si modules perform at or near their advertised levels, two brands perform well below their nameplate power ratings.[1] This information should be made widely available to the Kenyan public so that they will know which brands perform well and which perform poorly. If this sort of performance information is not disseminated broadly, the overall performance of the solar market as well as the interests of the Kenyan public may suffer due to the persistence of low quality brands in the market. This project and report are intended as a contribution to this information dissemination effort.

The strong performance of the three leading brands supports previous evidence indicating that good quality a-Si PV modules can be an excellent value for the money. At the same time, the very low performance of the two remaining brands is troubling, as many Kenyan consumers may lack the information to distinguish among the various competing brands. There is, therefore, a need for market institutions that ensure the quality and performance of solar products sold in the Kenya market.

This conclusion is strongly supported by a series of performance tests that we have conducted on a-Si modules in Kenya dating back to 1999.[2] The 1999 study played an important role in pressuring low performing brands of a-Si modules to improve or exit the market, even while it also verified that high quality brands of a-Si modules performed well. The result was a stronger solar market and a better served public. However, within a few years a new line of low performing a-Si modules entered the market. This confirms the need for vigilant quality monitoring. In other words, the mix of high and low performing brands identified in the recent 2004/05 tests is nothing new, and we should not expect performance problems to go away on a permanent basis even with the removal of the current low performing brands. Persistent problems require persistent solutions, and, in the absence of a vigilant and effective monitoring program, we can expect more quality problems in the future.

Summary of Test Results from 2004/05

The 2004/05 solar module performance results that we present in this report are the outcome of a joint effort implemented by researchers from Humboldt State University (HSU) and the University of California at Berkeley (UCB) and in the USA. We designed the study to contribute information about the performance of amorphous silicon solar modules sold in the Kenya market. The results that we report

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[1] See below for a detailed accounting of the test results as well as a discussion of actions taken by the respective companies in response to the results of the study.

[2] See Jacobson, et al., 2000a; Jacobson, et al., 2000b; Duke, et al., 2000; Jacobson, et al., 2001; Jacobson, 2002; Duke, et al., 2002; and Jacobson and Kammen, 2004 for results from previous solar testing efforts in Kenya. These papers are available online at http://socrates.berkeley.edu/~rael/papers.html#PV and http://www.humboldt.edu/~aej1.

are informational, and should not be construed as having a legal basis for the enforcement of government standards or any other form of involuntary corrective action.

In implementing this project, we have worked in conjunction with the Kenyan Renewable Energy Association (KEREA), as well as the respective Kenyan based import companies who sell the various brands of amorphous silicon (a-Si) modules included in this study. In particular, KEREA has coordinated a series of ongoing discussions within the Kenyan solar energy industry about key policy issues related to solar module quality. Solar import companies contributed funds to cover the retail cost of purchasing the modules tested in this study, as well as the cost of shipping the modules from Nairobi, Kenya to the USA. These funds were delivered to KEREA by the respective companies, and KEREA disbursed them to cover panel purchase and shipping costs.

Researchers from HSU and UCB coordinated all of the field activities related to selecting and purchasing the solar modules from retail shops in Kenya. We were assisted in this work by Maina Mumbi of Off-Grid Energy Alternative Technologies. HSU and UCB jointly covered all of the costs associated with solar module testing for the project. We acknowledge the Schatz Energy Research Center and the Energy Foundation of San Francisco for their generous support.

Sample Selection

We selected four modules for each of the five brands of a-Si modules in this study by purchasing them from retail shops in Kenya.[3] See Table 1 for information about the five brands included in the study. After selection, representatives from each of the respective import companies were given an opportunity to inspect the modules. All of the modules included in the tests were carefully inspected and were found to be free from visible physical defects[4]. According to the labels on the modules, all of the brands are nominally rated at 14 Watts. However, several companies have indicated that this value does not correspond to the maximum power at STC, and that the correct STC rating for their brand is 12 Watts.

Table 1. Brands of a-Si Solar Modules Included in the 2004/05 Study

a-Si Module Brand	Kenyan Import Company	Country of Origin
Free Energy Europe	Chloride Exide, Telesales	France
ICP-Solar	Sollatek	U.K. (Wales)
Shenzhen Topray #1 (eSolar)[5]	Kenital	China
Shenzhen Topray #2 (SunLink)[6]	Electric Link	China
Solar Cells	Bhatt Electronics	Croatia

Measurement Method

The solar module performance measurements reported in this study were made using an outdoor testing method that has an estimated accuracy of ±10%. This measurement method was developed, tested, and used in our earlier 1999 study. The tests involve measuring current-voltage (IV) curves for each module on a clear, sunny day. The results for each curve are normalized to standard test conditions (1000 W/m^2 and 25°C) using widely accepted equations. We use these normalized curves to estimate the maximum power output for each module for standard test conditions. See Jacobson, et al., 2000a for a more detailed description of the method.

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[3] Modules were purchased by our agent Maina Mumbi from retail shops in the towns of Narok, Molo, and Maai Mahiu as well as the capital city of Nairobi.

[4] The inspection was held in Nairobi on August 17, 2004. Representatives from four of the import companies attended, as well as representatives from KEREA, the Kenya Bureau of Standards (KEBS), and the University of California at Berkeley. One import company declined to send a representative.

[5] These modules were imported by Kenital from the Shenzhen Topray Solar Company. They were sold by Kenital under the "eSolar" brand name in Kenya.

[6] These modules were imported by Electric Link from the Shenzhen Topray Solar Company. They have been sold under at least two brand names in Kenya, including "SunLink" and "SunSolar."

The results reported in this study include measurements of the power output of new modules, as well as the performance of these same modules after a number of months of exposure to solar radiation. The performance of a-Si modules decreases during the first few months of exposure to the sun before stabilizing. This drop in performance is commonly called "Staebler-Wronski degradation" after the researchers who first identified the effect [Staebler and Wronski, 1977]. Because the amount of Staebler-Wronski degradation often varies from brand to brand, it is critical to base comparisons of a-Si modules on their final, stabilized performance after three to six months of exposure to the sun.[7]

Performance Test Results

The final, stabilized average maximum power output for each of the brands is given in Figure 1. These results indicate that the performance of three of the brands (Free Energy Europe, Solar Cells, and ICP-Solar) is consistent with what one would expect from high performing 12 Watt solar PV modules. The performance of the remaining two brands (eSolar and SunLink), both of which are purchased from the same manufacturer in China, is well below their advertised level of performance.

The data in Table 2 provide additional information about the relative performance of the five brands of a-Si modules. In the case of the high performing brands, all three began the process with a maximum power output that exceeded the nominal 14 Watt rating on their nameplate. The average initial performance of the ICP-Solar modules was particularly high at 17.2 Watts. As expected, the performance of all of the brands dropped over the first few months of exposure to the sun due to Staebler-Wronski degradation, and the final performance for the three top brands is consistent with the performance of modules that have a maximum power rating at standard test conditions of 12 Watts.

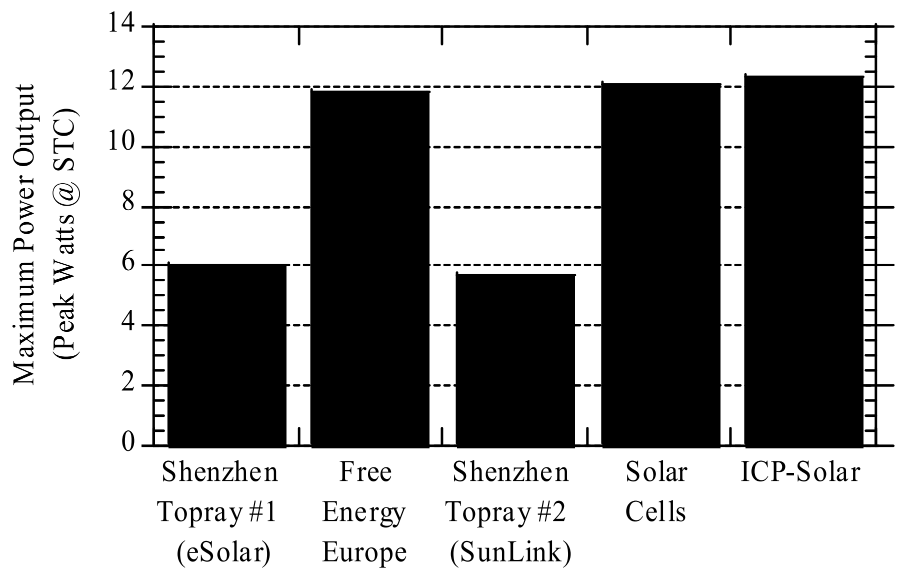

Figure 1. Average Stabilized Maximum Power Output for Five Brands of Amorphous Silicon Solar Modules Sold in Kenya[8]

It is notable that that the final performance of all three of these brands is close to 12 Watts despite the differences in their initial performance, as it confirms that the rate of Staebler-Wronski degradation differs from brand to brand. In this study, the average performance of the four ICP-Solar modules dropped by 29% prior to stabilization, compared to 21% for the Free Energy Europe modules and 20% for the Solar Cells modules. This highlights the importance of basing comparisons of relative performance on the final stabilized performance rather than on the initial power output.

[7] Crystalline silicon PV modules also experience a small amount of light induced degradation (generally on the order of 3-5%), but they typically stabilize after only a few hours of exposure to the sun [Green, 2005; Cereghetti, et al., 2003]. As a result, evaluating the power output of crystalline silicon modules does not require several months of light soaking, as is required in the case of a-Si modules.

[8] Maximum Power at Standard Test Conditions, STC, of 1000 W/m^2 and 25°C.

It is also important to note that the relative performance of all three of these brands is statistically identical. In other words, although the average performance of the four ICP-Solar modules tested in the study (12.3 Watts) was slightly higher than the performance of the Solar Cells (12.1 Watts) and the Free Energy Europe (11.8 Watts) modules, these differences are well within the margin of error of the measurements methods used in the study.[9]

One additional significant point is that, while the maximum power output of a solar module under standard test conditions is a key indicator of performance, other performance parameters such as durability and longevity are also important. In this area, Free Energy Europe deserves special credit for the high performance of its "C-version" a-Si module, which has passed the rigorous set of tests required for IEC certification.[10]

Table 2. Summary Performance Results for Five Brands of a-Si Solar Modules

a-Si Brand	# Modules in Original Sample	# Failed Modules (Mar 05)[11]	Avg. Initial Performance (Wp, STC)	Avg. Final Performance[12] (Wp, STC)	Final Performance 95% Confidence Interval (Wp)
Shenzhen Topray #1 (eSolar)[5]	4	3	9.1	6.0	n/a[13]
Free Energy Europe	4	0	14.9	11.8	10.7 to 12.9
Shenzhen Topray #2 (SunLink)[6]	4	1	9.1	5.7	5.4 to 6.1
Solar Cells	4	0	15.2	12.1	11.2 to 13.0
ICP-Solar	4	0	17.3	12.3	10.3 to 14.3

As noted above, the performance of the two low performing brands is well below their advertised nameplate ratings. The average stabilized performance for both lines of Shenzhen Topray a-Si modules was approximately 6 Watts, which is well below acceptable levels for 14 Watt rated modules. The low performance of these modules may be caused by impurities introduced during production and/or other quality control problems in the manufacturing process.

In addition to low power output, we observed problems with module failure for both lines of Shenzhen Topray a-Si modules. In the case of the modules sold under the eSolar brand name, three of the four modules failed completely during their first few months on the test rack. One of the four modules sold under the SunLink brand name also failed during this time period. These failures appear to be caused by water intrusion that led to delamination of the active material of the a-Si modules. See Figure 2 for an illustration of this delamination.

[9] The 95% confidence intervals reported in Table 1 confirm this conclusion. These intervals indicate, with 95% confidence, that the average stabilized performance any Free Energy Europe module manufactured around the same time as the modules tested in the study is likely to fall between 10.7 and 12.9 Watts. Likewise, the range for Solar Cells modules is from 11.2 to 13.0 Watts, and the range for ICP-Solar modules is from 10.3 to 14.3 Watts. The fact that these ranges overlap with each other indicates that we cannot be certain, based on the tests carried out in this study, which of the brands has the highest performance. We would need to test a larger number of each module type in order to determine differences in the relative performance of the respective brands.

[10] The "C-Version" of Free Energy Europe's a-Si module was certified according to the International Electrotechnical Commission (IEC) 61646 standard. See http://www.free-energy.net/ and http://www.iecee.org/pv/html/pvstandards.htm for additional information.

[11] Failed modules are defined as those with a maximum power output below 1 Wp as of March 1, 2005.

[12] The average final performance is based on the maximum power output of all "working" modules (i.e. modules that had failed outright were excluded from the sample for the purpose of estimating the average final performance).

[13] It was not possible to estimate a confidence interval for the final performance of the Shenzhen Topray modules sold under the "eSolar" brand, as only one module remained in operation.

Figure 2. Water Intrusion Related Delamination in a Shenzhen Topray a-Si Solar Module.

Response to Study Results by Kenyan Companies

To its credit, Kenital – the company that marketed the Shenzhen Topray amorphous silicon modules under its eSolar brand name – has responded to the results of this study by discontinuing sales of these low performing modules. Kenital is now importing and distributing the Croatian made "Solar Cells" a-Si modules, which it markets under the eSolar brand name. It is therefore important to note that while Kenital continues to sell a-Si modules under the eSolar brand, these modules are now a high performing product.

Electric Link, the other company that has been importing Shenzhen Topray modules, has agreed to suspend imports of these modules. However, they have continued to sell their remaining stock of these modules under brand names including "SunLink" and "SunSolar." These ongoing sales are based on an agreement between Electric Link, the other solar import companies, and representatives of the Kenya Renewable Energy Association (KEREA) that was negotiated at a meeting in October of 2004.[14] According to the agreement, Electric Link was to market their remaining stock of Shenzhen Topray a-Si modules at a 10 Watt power rating.[15] Because the remaining stock was relatively large (2 shipping containers), these low performing modules remain available in the Kenya market. The fact that the actual performance of the Shenzhen Topray a-Si modules tested in the study falls well below even the reduced 10 Watt rating raises concerns about the continued sale of this product.

In addition, evidence from several sources confirms that, in at least some cases, the Shenzhen Topray/SunLink/SunSolar modules are being marketed to Kenyan consumers as 12 Watt modules. This appears to be in contravention to the agreement that the remaining stock of these modules would be sold under a 10 Watt label. We therefore strongly recommend that the sales of these low quality modules be discontinued.

In any case, while the pledge by the two importers of the low performing brands to suspend imports of these products is encouraging, a review of the history of a-Si modules in Kenya indicates that these actions are unlikely to represent a permanent solution to quality problems in the solar market. Instead, this history strongly suggests a need for an ongoing monitoring program that involves testing and publishing the performance of solar PV modules sold in the market on a regular basis.

A Brief History of a-Si Testing in Kenya

Amorphous silicon solar modules entered the Kenya market in 1989. Sales grew rapidly, and by the late 1990s a-Si modules had gained a significant share of the overall solar PV market in Kenya. See Figure 3 for a record of amorphous and crystalline PV sales in Kenya from 1987 to 2001.

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[14] We (the authors) were not parties to the agreement.

[15] The parties appear to have selected the 10 Watt rating based on the average initial (i.e. pre-light soaking) performance of the Shenzhen Topray modules, which was 9.1 Watts. At the time of the October meeting, results for the final performance of the modules were not yet available.

Although the high sales figures indicate commercial success, a-Si technology has had a mixed reputation for quality in Kenya [e.g. see Ochieng, 1999]. The first generation of a-Si modules sold in Kenya were made by the Chronar Corporation, which went bankrupt in the mid-1990s in part due to quality related reputation problems [e.g. see Crawford, 1997]. Several of Chronar's successors made high performing a-Si modules, but low quality versions of the technology also continued to be sold. This situation created a serious problem in the market, as many potential solar customers were unable to determine which brands performed well and which did not [Duke, et al., 2002].

The debate about quality led to a study of a-Si module performance in 1999. This joint study was carried out by researchers from the University of California at Berkeley and Princeton University of the U.S. in collaboration with Energy Alternatives Africa (EAA) of Nairobi.[16]

Amorphous PV Testing in 1999

In 1999 the Berkeley-Princeton-EAA research team carried out a field study that included performance measurements of 130 a-Si modules and 17 crystalline modules at 145 homes in rural Kenya. In addition, we also purchased 14 new a-Si modules in Nairobi that we tested at outdoor testing facilities in the U.S. and Kenya.

At the time of the study, the large majority of the a-Si modules sold in Kenya were manufactured by three competing companies. The results of the study, which are summarized in Figure 4, indicated that a-Si modules made by two of the three companies (Free Energy Europe[17] and Koncar[18]) performed reasonably well, while modules manufactured by the third company (Intersolar[19]) performed well below their advertised levels. Additional performance results are provided in Table 3.[20]

These results indicated that the high performing brands of a-Si modules were an effective, low cost alternative to crystalline PV. However, the poor performance of the low performing brand indicated a need for measures to ensure the high quality of all modules sold in the Kenya PV market.

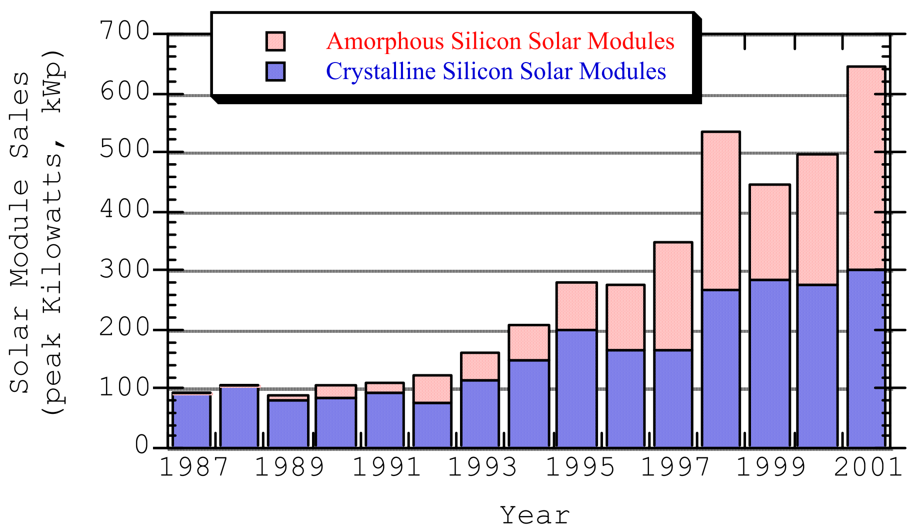

Figure 3. Solar Module Sales from 1987 to 2001
Data sources: Hankins and Bess, 1994; Hankins, 2000; ESDA, 2003

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[16] The authors of this study were two of the key participants in the 1999 study. Note that Energy Alternatives Africa (EAA) has since changed its name to Energy for Sustainable Development, Africa (ESDA).
[17] Free Energy Europe purchased the factory in France where its a-Si modules are manufactured from Neste Advanced Power Systems (NAPS) in 1998 [Duke, et al., 2000].
[18] Koncar modules are now sold in Kenya under the brand name "Solar Cells".
[19] Intersolar was purchased by ICP-Solar in 2003 [Lane, 2003].
[20] See Jacobson, et al., 2000a, Jacobson, et al., 2000b, Duke, et al., 2000, and Duke, et al., 2002 for more information about the study.

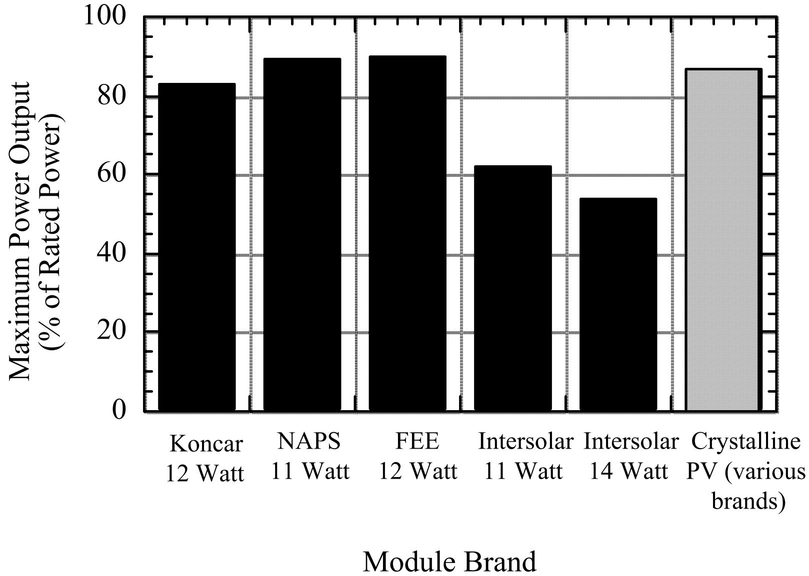

Figure 4. Average Performance for Solar PV Modules Tested in 1999

Table 3. Performance Summary for a-Si PV Panels Tested in Kenya During 1999

Panel Type	Rated Max. Power (Watts)	Average Measured Max. Power (Watts)	Percentage of Rated Output	Average Age of Modules (years)	# Modules Tested
Koncar (Solar Cells)	12	10.0	83%	2.8	31
NAPS	11	9.7	88%	3.1	31
Free Energy Europe	12	10.6	89%	0.9	32
Intersolar "Phoenix"	11	6.8	61%	2.4	5
Intersolar "Phoenix Gold"	14	7.7	55%	1.5	12
APS	25	22.5	90%	5.0	1
Chronar	10	7.2	72%	5.9	4

Performance Improvements in Intersolar and ICP-Solar a-Si Modules, 1999 to 2005

To its credit, Intersolar made considerable investments to improve the performance of its a-Si products in the years following the 1999 study. These investments resulted in improved performance over time, as documented in Figure 5. These results represent a significant success story, as the low performing Intersolar modules of the 1990s have been replaced with the current generation of high performing ICP-Solar a-Si modules.

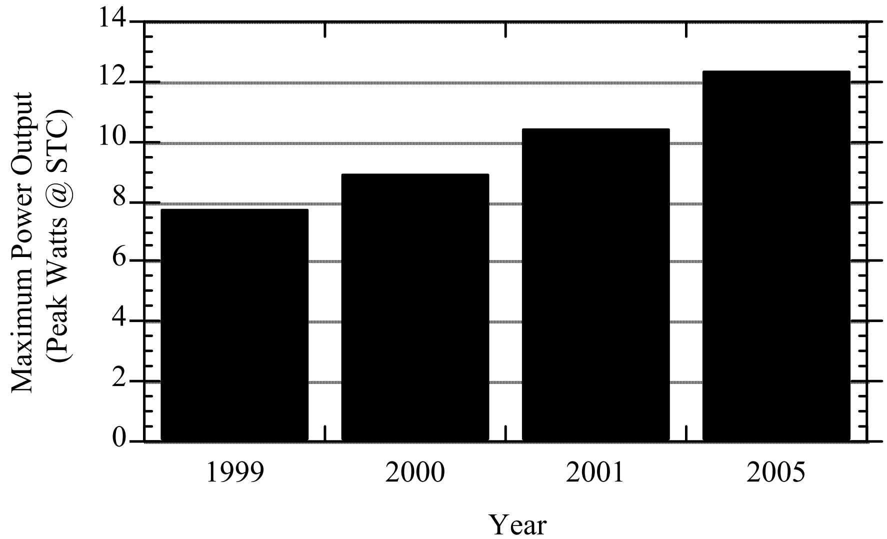

Figure 5. Performance Trend for 14 Watt Rated Intersolar / ICP-Solar Modules from 1999 to 2005[21]

New Low Performing Brands Enter the Market

However, while the improvements made by Intersolar and ICP-Solar are very encouraging, these gains have not eliminated the quality problems with a-Si technology in the Kenya solar market. That is, even while the Intersolar / ICP-Solar brand has achieved a level of performance that is comparable with Free Energy Europe and Solar Cells, our performance measurements from 2004/05 document that other low performing brands have entered the market. These results confirm that quality problems in solar markets cannot be solved by focusing on the performance of individual brands alone. Rather, institutional solutions that persistently require high performance for all brands are needed to ensure quality.

Amorphous Silicon Module Performance and Product Labeling

One final issue of note is related to standards for labeling a-Si modules sold in Kenya. As mentioned above, the power output of the three high performing brands of a-Si modules tested in the 2004/05 study is consistent with modules that are rated to deliver 12 Watts under standard test conditions. This performance appears to differ from the nameplate power ratings of these modules, as all of the modules in the study were nominally marketed as 14 Watt modules.[22]

While some of the participating companies have indicated that they plan to change their labels to include information about the power output of the modules at STC, several company representatives have argued that they should be permitted to maintain the 14 Watt power rating.

One company, ICP-Solar, claims that the most recent version of its modules have a higher performance level than the modules tested in the 2004/05 study. They maintain that the new modules achieve a stabilized (i.e. post-Staebler-Wronski) power output of 14 Watts under standard test conditions, and that they therefore intend to report this performance on the product label. We have not tested this new version of the ICP-Solar modules, and we cannot, therefore, verify whether they achieve this level of performance.

Another argument in favor of maintaining the 14 Watt rating is based on the claim that at least some brands of amorphous silicon solar modules deliver approximately 15% more watt-hours of electrical

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[21] The performance data for 1999 are from field tests of the 12 Intersolar "Phoenix Gold" modules included in the Berkeley-Princeton-EAA study. The 2000 and 2001 results are based on measurements of two separate batches of four "Phoenix Gold" modules by author Jacobson at UC Berkeley. The 2005 results are based on the performance of the four ICP-Solar module included in the current study.

[22] According to standards adopted by the Kenya Bureau of Standards (KEBS), the power rating given on the label of solar modules marketed in Kenya should be the maximum power output at standard test conditions of 1000 W/m^2 and 25°C [KEBS, 2003].

energy than crystalline solar modules for every watt of power output at standard test conditions. In other words, the claim is that high quality a-Si modules deliver more watt-hours per peak watt of rated power than crystalline PV modules.[23]

This claim is supported by a modeling study of the relative performance of several different types of amorphous and crystalline solar modules in a grid connected application in the Netherlands [Eikelboom and Jansen, 2000]. This study indicated that a-Si solar modules manufactured by Unisolar and Free Energy Europe would deliver approximately 12% to 20% more watt-hours per rated peak watt than several brands of crystalline solar modules. Thus, some a-Si manufacturers argue that they should be allowed to increase the nominal power rating on their modules to account for the relative advantage in watt-hour performance provided by high performing brands a-Si modules.

While the results of the study by Eikelboom and Jansen are interesting, there are several reasons to treat them with caution.[24] We therefore recommend the continued use of the current standard requiring that all solar PV modules sold in Kenya be labeled according to their stabilized maximum power output under standard test conditions.

Conclusion

In this report we present test results from 2004-05 which indicate that the majority of the brands of amorphous silicon solar modules sold in Kenya perform well, and they remain a good value for their price compared to crystalline PV modules of comparable sizes. Free Energy Europe and Solar Cells brand modules deserve special mention for their long track record of producing consistently high quality goods, while ICP-Solar merits credit for significant improvements in recent years. Our measurements indicate that the power output of these three brands is now similar, with each delivering approximately 12 Watts of power under standard test conditions (STC).

However, we also found that modules imported from the Shenzhen Topray Solar Company performed well below their advertised levels. In response to these results, both of the Kenyan based companies that marketed these modules have committed to suspend further imports. One of the companies, Kenital, is now marketing the high quality Croatian made Solar Cells modules under the eSolar brand name in place of the low performing line of Chinese made a-Si modules. The other company, Electric Link, continues to sell their remaining stock of the Shenzhen Topray modules under the SunLink and SunSolar brand names. While Electric Link agreed to sell this product under a 10 Watt label, in at least some cases they have been marketed as a 12 Watt product. Given the extremely low performance of this line of modules, we strongly recommend that they be withdrawn from the market. Resumption of sales of the Shenzhen Topray brand should proceed only when they achieve acceptable performance levels.

Performance results for a-Si modules from 1999, in combination with the 2004-05 measurements from this study, indicate that the presence of low performing brands is nothing new in the Kenya solar market. Thus, while the 1999 study played an important role in pressuring low performing brands to

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[23] The reason for possible differences in the number of watt-hours delivered per rated peak watt may be related to the ability of a-Si modules to maintain higher efficiency at low light levels (e.g. on cloudy days) than crystalline modules. Additionally, a-Si modules suffer smaller voltage losses at high temperatures than crystalline modules. Both of these characteristics may contribute to differences in the relative performance over time of amorphous and crystalline solar modules [e.g. see Eikelboom and Jansen, 2000].

[24] First, in the study Eikelboom and Jansen evaluated the relative performance of the technologies in a grid connected application that involved maximum power point tracking rather than in a battery based application. The relative performance of the respective technologies in battery based systems may vary significantly from the results presented in the study. Second, in the study, the performance of the various modules under low light conditions was estimated by tilting the modules at an oblique angle to the sun's beam on a clear day. This approach is likely to produce results that differ from module performance under low light conditions that are caused by cloud cover. Nonetheless, the modelers used the oblique tilt measurements to estimate module performance for all low light conditions. This approach may result in significant errors in the estimate of the relative performance of the various modules under diffuse light conditions. We (the authors of this report) thank Charles Chamberlin of Humboldt State University for his insights on the methods used in the study by Eikelboom and Jansen [2000]. Third, studies by other researchers have failed to replicate Eikelboom and Jansen's results. For example, Faiman, et al. [2003] report results that appear to refute the claim that a-Si modules produce more energy per rated watt than crystalline silicon PV modules.

improve or exit the market, the 2004-05 study verifies the need for ongoing vigilance if high quality it to be maintained.

Finally, although this study focuses on the performance of amorphous silicon modules in Kenya, the lessons learned apply to other solar products as well as to solar markets elsewhere in Africa and beyond. The Kenya Bureau of Standards has initiated product testing for batteries, and we applaud this effort. Important next steps along these lines include establishing ongoing testing programs for both amorphous and crystalline solar PV modules, as well as other products such as charge controllers and DC lamps. The solar energy research laboratory under the direction of Dr. Mwamburi of the Physics Department at Moi University in Eldoret offers a promising Kenya-based site for such testing.

As solar markets develop throughout Africa, vigilant, effective, and transparent monitoring programs are needed to ensure quality and to protect the public interest. We at Humboldt State University and the University of California, Berkeley intend to do our part to support these ongoing efforts.

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