Stakeholder Feedback on the Integration of the Quality Assurance Frameworks for Pico-solar Products and SHS Kits

November 2016

We thank everyone who provided feedback on the proposal to integrate the QA frameworks for pico-solar products and solar home system (SHS) kits in June of 2016. Based on the feedback we have received and the experience we have gained from conducting pilot and validation testing on a range of both pico-products and SHS kits, we are nearly ready to submit a revised version of IEC TS 62257-9-5 that covers off-grid solar products ranging from less than one watt up to 350 watts. We believe the proposed framework will create a unified set of test methods that can more easily be maintained and will ensure a more efficient and appropriate testing process.

In this survey, we received comments from twelve individuals or organizations, including four manufacturer/assemblers, three development agencies/NGOs, four test laboratories/researchers and one end user. Many more stakeholders registered their interest in the topics, but did not provide specific comments.

A synthesis of comments on each question or sub-topic is presented, along with responses from the Lighting Global team. While text was altered from the original submissions, alterations were not intended to change the meaning of the comment, but only to condense responses and protect the anonymity of the respondent. Similar comments from multiple stakeholders were combined.

In addition to the full feedback presented below, Table 1 presents a summary of the changes that were made to the Quality Standards and/or Test Methods in response to stakeholder feedback. We have also incorporated a number of changes over the past year based on stakeholder feedback we received on the draft test methods and revised Quality Standards for SHS kits. These changes are listed in Table 2, while a full list of this stakeholder feedback will be presented in separate document that will be released soon. For each change, we list where the change will be made (i.e. which document and where in that document) and when we anticipate that the change will be implemented. Most changes will not be implemented until the revised version of IEC 62257-9-5 is published, which will likely occur after May 2017. In general, changes to the SHS kit test methods will be made in the existing Lighting Global Quality Assurance Protocols for SHS Kits and will be submitted for inclusion in IEC TS 62257-9-5. Changes that influence pico-solar product testing will not go into effect until the next edition of IEC TS 62257-9-5 is published.

Table 1. Summary of changes made in response to stakeholder feedback (1 of 2)

Change based on stakeholder feedback	Where will the change be made?	When will the change be made?
Increase the upper bound of the peak PV module power covered by the test methods to 350 W.	•Test methods: - Clause 1: Scope •SHS Kit Quality Standards	Immediately for SHS Kits, and later included in IEC 62257-9-5
Merge the methods for pico-products and SHS kits into a single document that covers off-grid energy products from less than 1 W up to 350 W.	•Throughout test methods	When revision of IEC 62257-9-5 is published, likely after May 2017
Consider requiring factory certifications or safety tests for large PV modules, such as those described in IEC 61730.	--	No change now, but will consider in future
Require the Assessment of DC Ports, the Energy Service Calculations (ESC), and related tests for all products with ports and allow the Energy Service Calculations to be used in place of multiple solar run time tests. [This was proposed by Lighting Global and largely supported by stakeholders.] As suggested by a stakeholder, we are conducting additional validation testing to ensure that the ESC adequately assess the solar run time for small products. We are in the process of making minor changes to the ESC methods to address issues identified during this validation testing. Once the issues are addressed, we intend to submit the revisions to the IEC.	•Test methods: - Clauses 6 – 9: QTM, MCM, ISM, AVM - Annex EE: Assessment of DC Ports - Annex FF: Appliance Tests - Annex GG: Energy Service Calculations •Standardized Specifications Sheet	When revision of IEC 62257-9-5 is published, likely after May 2017
Consider additional performance reporting requirements for products with ports and appliances to manage user expectations.	--	No change now, but will consider in future
Require the miswiring test, PV overvoltage, and output overload tests for all products with ports, regardless of size. Additionally, included appliances would undergo an assessment of operating voltage range compatibility. [This was proposed by Lighting Global and largely supported by stakeholders.]	•Test methods: - Clauses 6 – 9: QTM, MCM, ISM, AVM - Annex DD: Protection Tests	When revision of IEC 62257-9-5 is published, likely after May 2017
Stop measuring the "usable surface area with illumination greater than 50 lux." The test could still be conducted if necessary to evaluate advertising claims, but the only required element would be to determine the "full-width half-max" angle which is used to classify a light as being narrow, wide or omni-directional. [This was proposed by Lighting Global and largely supported by stakeholders.]	•Test methods: - Clauses 6 – 9: QTM, MCM, ISM, AVM - Annex T: Light Distribution •Standardized Specifications Sheet	When revision of IEC 62257-9-5 is published, likely after May 2017
Continue to require small (pico) products to be tested with a sample size of six and larger (SHS kits) products to be tested with a sample size of four. [This was proposed by Lighting Global and largely supported by stakeholders.]	•Quality Standards •Test methods: - Clauses 6 – 9: QTM, MCM, ISM, AVM - Annex E: Product Sampling	This is the current practice, though the dividing line will change when revision of IEC 62257-9-5 is published
Set the dividing line between product classes at 10 W based on the PV panel rating. This dividing line would apply to the required sample sizes and the additional Quality Standards for SHS kits, such as the wire and cable sizing declaration, the battery replacement statement, user manual requirements, and warranty terms.	•Quality Standards •Test methods: - Clauses 6 – 9: QTM, MCM, ISM, AVM - Annex E: Product Sampling	When revision of IEC 62257-9-5 is published, likely after May 2017

Table 1. Summary of changes made in response to stakeholder feedback (2 of 2)

Change based on stakeholder feedback	Where will the change be made?	When will the change be made?
Extend the Quality Standards for Ports, PV Overvoltage Protection, Miswiring Protection, Circuit and Overload Protection, and additional Battery Protection for Lithium Batteries to pico-products with ports. [This was proposed by Lighting Global and largely supported by stakeholders.]	•Quality Standards •Test methods: - Annex D: Manufacturer self-reported information - Annex DD: Protection Tests	When revision of IEC 62257-9-5 is published, likely after May 2017
Clarify the overvoltage protection limits for individual cells of lithium batteries. Clarifications include: Manufactures must declare that the battery has overcharge protection for individual cells or sets of parallel-connected cells. The voltage limit for the individual cells can be higher than the per-cell voltage limit for the entire pack; as always, we will typically accept limits specified by the battery manufacturer in lieu of our recommended values.	•Quality Standards	Immediately for SHS Kits; change will also apply to pico-products after revision of IEC 62257-9-5 is published
Consider extending UV protection requirements for PV (and other outdoor) cables to pico-products.	--	No change now, but will consider in future. The Outdoor Cable Policy will be enforced for SHS kits in early 2017.
Increase the lumen maintenance threshold for all products from 85% to 90%. [This was proposed by Lighting Global and largely supported by stakeholders.]	•Quality Standards	When revision of IEC 62257-9-5 is published, likely after May 2017
Decrease the warranty requirement for SHS Kits to 2 years for the system and battery, and 1 year for all appliances. Plan to revisit the warranty requirements for larger systems in the future given that the same warranty requirements may not be appropriate for the entire 10 W - 350 W range.	•Quality Standards	Immediately for SHS Kits; change will also apply to all products ≥ 10 W after revision of IEC 62257-9-5 is published
Clarify that USB charging adapters are only required to be covered by a 1-year warranty.	•Quality Standards	Immediately for SHS kits
Amend the passing thresholds for the switch, gooseneck, connector, moving parts, and strain relief durability tests to no longer allow for any failures. [This was proposed by Lighting Global and largely supported by stakeholders.]	•Quality Standards	Immediately for all products
Investigate and develop test methods for assessing connector strain relief, evaluate connectors that break when pulled sideways, and improve the switch test so that it more realistically evaluates switches in the field.	--	No change now, but will consider in future
Explore the issue of voltage collapse to determine if a standard or additional test is warranted.	--	No change now, but will consider in future
Continue to develop test procedures and policy for assessing mobile device charging claims.	--	No change now, but will consider in future
Continue to determine ways to minimize difficulties associated with sample selection while still ensuring the test samples are representative of the products in the market.	--	No change now, but will consider in future
Develop an Eco Design Note that provides a list of recommendations for the design and manufacture of repairable products.	--	No change now, but will consider in future; Developing an Eco Design Note on topic

Table 2. Changes made to Test Methods and Quality Standards for SHS Kits based on prior stakeholder feedback

Change based on stakeholder feedback	Where was the change made?
Improve the introductory text to clarify what types of SHS Kits are covered by the Quality Standards.	•Introduction in Quality Standards
Change the wording of the eligibility criteria to: "All components required to provide basic energy services are **sold/installed** as a kit."	•Eligibility Criteria in Quality Standards •Test methods: - Clause 1: Scope
Decrease the allowable nominal system voltage to 24VDC.	•Eligibility Criteria in Quality Standards •Test methods: - Clause 1: Scope
Remove battery replaceability requirement and instead require that the manual clearly state either: (i) specifications for replacement batteries and directions for replacing them, (ii) how someone can get their battery replaced at service centers, or (iii) that the batteries are not replaceable. Further, the packaging must include a short statement regarding whether the battery is replaceable. [Based on feedback from many manufacturers, we do not feel comfortable requiring that batteries be replaceable. Some PAYG companies were concerned about this requirement because they seal the battery compartment and all electronic components to prevent tampering. To address this while still responding to end-user interest to have systems that are repairable (this has been a common sentiment expressed by end-users in multiple focus groups and in other venues), we believe that it is important to provide consumers with clear information about whether batteries are replaceable and, if so, how to get them replaced.]	•Quality Standards
Adjust the USB requirements to a max of 5.5 V and allow for voltages to drop to 4.5 V under load [These limits exceed the recommendations of the USB Battery Charging Specification (4.75-5.25 V), but they address concerns regarding Nokia phones charging at higher voltages. The change also allows output voltages to be pulled down under load to improve charging efficiency in phones that use linear charging.]	•Quality Standards
Change 12 V port requirement to: "All ports advertised or reasonably expected to provide 12 V must maintain a voltage between 10.5 – 15 V during normal operation. In cases where special features reduce the voltage below 10.5 V, the feature must be clearly described in the user manual and the port must be marked to indicate that the port is not a standard 12 V port (removable stickers are acceptable)."	•Quality Standards
Add that the battery warranty requirement assumes that batteries will maintain 80% capacity at 2 years. [A respondent noted that the battery warranty did not cover capacity loss, which is the primary function of the battery.]	•Quality Standards
Provide more guidance in the Quality Standards as to which switches/connectors may be cycled only 100 times.	•Quality Standards
Provide more guidance on the requirements for PV and other outdoor cables.	•Quality Standards •Lighting Global Outdoor Cable Policy

Comments on Integration of the Quality Assurance Frameworks for Pico-solar Products and SHS Kits

1 Comments regarding the plan to incorporate the SHS Kit test methods into IEC 62257-9-5:

Stakeholders across the sector agreed that incorporating the test methods for pico-products and SHS kits into a single document is appropriate. Respondents suggested that a single document would simplify government engagement regarding the regulation of SHS kits and that a single document would make the methods easier to reference during testing.

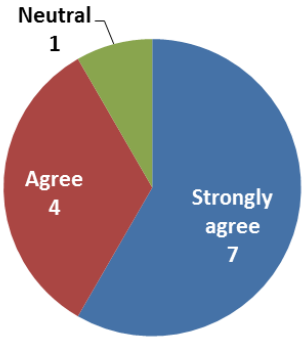

Figure 1. Do you agree with the plan to incorporate the SHS Kit test methods into IEC 62257-9-5? Of the twelve respondents, eleven agreed and one remained neutral.

Several respondents commented on the eligibility criteria; one noted the need to test systems [with variable components] instead of only fixed kits including fixed lamps and panels, while others noted that the upper bound for eligibility based on wattage is too low. One respondent suggested that the upper limit should be 500 Wp.

One respondent recommended that solar panels larger than 10 W be tested according to IEC 61215 and IEC 61730, and that factories which produce the modules should have the ISO 9001/14001/OHSAS 18001 to guarantee minimum production standards.

RESPONSE: Based on the positive feedback, we plan to move forward with incorporating the test methods for SHS kits into IEC 62257-9-5. In response to requests in this most recent stakeholder process and prior conversations, we plan to extend the scope of the test methods to cover SHS kits up to 350 Wp with a maximum nominal system voltage of 24 V. This limit will enable the inclusion of some common commercial modules, while minimizing risks due to high voltage or arcing. We do still plan to require that the products be sold as distinct kits; however, the energy service calculations make it easier for additional appliances to be included or removed from a kit. Additionally, we offer the "Family of Products" policy, which enables the verification of an entire product line following evaluation according to a custom test plan that covers at least half of the components in the line.

In an effort to minimize the cost and time required for testing, we have decided not to require that panels larger than 10 W meet the performance standards of IEC 61215. However, we acknowledge that these are rigorous tests for PV modules and therefore have included procedures to use results from IEC 61215 in lieu of, or as inputs to, the test methods included in IEC 62257-9-5. Currently, the methods in IEC 62257-9-5 do not include safety tests for PV modules, such as those described in IEC 61730, or requirements for factory certifications. The methods in IEC 62257-9-5 only assess performance, workmanship and durability. With the inclusion of larger modules, it may be appropriate for Lighting Global to require IEC 61730 and/or factory certifications. These requirements will not be added at this time, but may be discussed in future stakeholder outreach.

2 Comments about the proposal to conduct the Ports test, Energy Service Calculations and related tests for products with ports:

Most of the respondents agreed that it was appropriate to extend the relevant tests to all products with ports. Comments included that the additional testing will build consumer confidence in the lab test results and prevent damage to non-matching components. Another noted that the ports and energy service calculations would allow the test lab to only conduct the full-battery run time (FBRT) and solar run time (SRT) tests once instead of for multiple settings and configurations, which could save time.

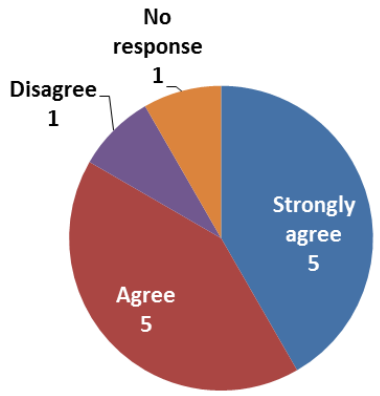

Figure 2. Do you agree with the proposal to conduct the Ports test, Energy Service Calculations and related tests for products with ports? Of the twelve respondents, eleven agreed, one disagreed and one did not respond.

Additionally, a respondent noted that a major issue seen in the market is ports and plugs which are not physically compatible, such as barrel plugs in which a 2.1 mm male pin is used with a 2.5 mm female plug, resulting in a plug which fits together, but provides a poor electrical connection.

The respondent who disagreed with conducting ports tests on all products with ports was concerned about the added cost due to requiring additional tests for pico-products and asked that we provide a quote from the test labs to better understand the cost implications.

RESPONSE: Based on the support for this change, we intend to require the Assessment of DC Ports, the Energy Service Calculations, and related tests for all products with ports. Based on conversations with test laboratories, we believe that these tests will come with the following cost implications:

- For products with included appliances, this change would save time during testing and therefore reduce testing costs from what would otherwise be required [Note that in some cases historically, the test labs have not adequately charged for the additional testing required for appliances. As a result, the labs have not fully recovered the cost of testing in these cases. The implication of the proposed change to the methods is that the actual cost to the laboratories of testing products with appliances will be the same or decrease, but the price the manufacturer is charged may increase, in some cases by 50% or more, depending on the number of appliances. In practice laboratories are taking steps to adjust their pricing to cover the full cost of testing in any case, so prices would increase with or without the change.]
- For products with multiple different types of ports, but no included appliances, the addition of these tests could increase the cost of testing by up to 10%.
- For products with no appliances but a single port, the effort and cost of testing would likely not change. For products with a single port that can be used for mobile phone charging, the method would enable the mobile phone charging capabilities of the port to be assessed.

While the Assessment of DC Ports does not directly assess whether a plug makes a good electrical connection, this issue often arises during the course of testing. If two components do not make a good electrical connection, the issue can either cause the product to not function properly or can impact a

product's measured performance. In either case, the issue should be identified during testing and would need to be addressed in order to meet the Lighting Global Quality Standards.

3 Comments on whether the Energy Service Calculations could serve as an acceptable replacement for additional solar run time tests for all products [Note, the proposal was for the energy service calculations to be applied to all pico-solar products, even those without ports, to reduce testing time and costs by only requiring a single solar run time test be conducted, rather than one for each setting or lighting configuration]:

Most respondents supported the proposal to use the Energy Service Calculations in place of multiple solar run time tests. One respondent stated that they hope the change will make independent testing of lamps, battery box and panels possible. Two acknowledged that the change will save on time and money for both the testing lab and the client and one noted that for many systems, light output may be secondary to other uses, so providing a more comprehensive assessment of energy service is appropriate.

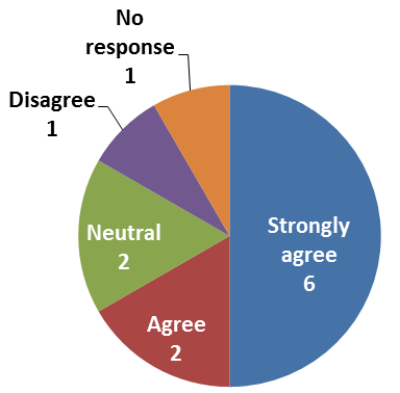

Figure 3. Do you agree that the Energy Service Calculations could serve as an acceptable replacement for additional solar run time tests? Of the twelve respondents, eight agreed, two remained neutral, one disagreed and one did not respond.

Regarding the Energy Service Calculations, one respondent noted that there needs to be a way in which these figures are meaningful to a naïve user and to manage their expectations of what the system can do. Another emphasized that both the maximum energy available when a battery is fully charged must be reported, as well as the energy available from daily generation. Another respondent suggested the following measurements be reported:

- maximum usage lighting only (all lights included on) after a standard solar day
- maximum usage for each appliance included (used alone), in addition to a foreseen normal usage of lights (4h/day for all lights included) after a standard solar day
- maximum usage for all appliances included (including lights, or in addition to 4h lighting) after a standard solar day

Three respondents expressed concerns with the use of the energy service calculations:

- One noted that it is crucial to consider performance reduction over time in a measurement of energy output.
- A second asked that we conduct an analysis on the degree of accuracy of these methods, including an assessment of the percent variation between multiple test runs for an individual product.
- A third noted that in experience with using the energy service calculations, the calculations did not align with their internal testing. They asked if the full-battery run time and solar run time tests can be offered as an alternate verification pathway.

RESPONSE: Given the generally positive response, at this time, we plan to allow for the energy service calculations to be used in place of multiple solar run time tests for all products. As suggested by one of the respondents, we are in the process of conducting validation testing to ensure that the energy service

calculations will accurately assess the full-battery and solar run time. When this validation testing is complete, we will share the results and any proposed changes to the methods, as well as address questions regarding what can be done if results from the energy service calculations do not align with previous testing or internal testing.

The suggestion that we consider the performance reduction over time is interesting, though we do not intend to modify the performance estimates at this time. We do have three tests that help to assess performance reduction. One is the battery durability test, which ensures that batteries stored in adverse conditions still maintain at least 75% of their original capacity. Another is the lumen maintenance test, which ensures that the LED light output maintains its brightness after 2000 hours of constant use. The third is specific to amorphous PV modules, which can often decrease in performance after their initial exposure to sunlight. Amorphous PV modules must be placed outdoors in the sun for 30 days prior to assessing the PV power to account for the potential decrease in performance.

As with the SHS kits, we will adapt the Standardized Specifications Sheet to present the information about energy service to the viewer. The energy service calculations would assess the available energy and run times both for a fully charged battery and for a battery charged after a standard solar day. As suggested, the combinations presented would include a scenario for just lighting appliances, for each appliance used individually, and for all appliances used at once. We have not yet determined if additional "performance reporting requirements" should be required for products that offer services beyond lighting. Currently, products smaller than 10 W are required to present the light output and solar run time for the highest setting, and include a statement regarding the impact of mobile phone charging or other auxiliary uses on the run time. Products larger than 10 W are required to state the PV module maximum power rating for the product. We are interested in opening a discussion regarding appropriate performance reporting requirements for products with ports and appliances.

Though we will continue to require that products be tested and sold as distinct kits, the energy service calculations will make it easier for companies to add or remove PV modules or appliances from the product without as much retesting.

4 Comments on the proposal to conduct protection tests for pico-solar products:

Most respondents were supportive of conducting the protection tests on products with ports.

One respondent suggested that these tests could act as confirmatory tests, but each product should also provide certificates of prior lab testing for the same aspects.

Another suggested that only products with batteries larger than 1000 mAh should be required to undergo the protection tests because these products do not pose a high risk.

The respondent who disagreed with the proposal was concerned that the additional tests would increase the testing fee, which they state is already very high, especially for a complicated product with ports and appliances. They

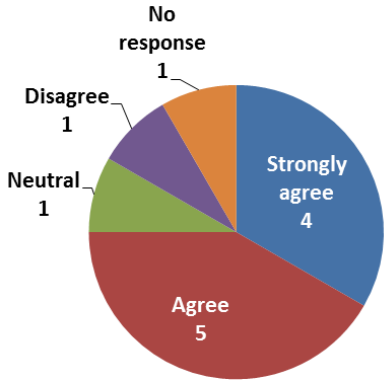

Figure 4. Do you agree with the proposal to conduct protection tests for pico-solar products? Of the twelve respondents, nine agreed, one remained neutral, one disagreed and one did not respond.

requested that we provide an estimate from the test labs to understand the additional cost due to these tests.

RESPONSE: We intend to move forward with requiring the miswiring test, PV overvoltage, and output overload tests for all products with ports, regardless of size. Additionally, included appliances would undergo an assessment of operating voltage range compatibility. To minimize the overall cost of testing to the manufacturer, we will not require certificates of outside testing beyond the protection tests described in IEC 62257-9-5. Though we acknowledge that smaller products pose a lower safety risk, we still think that these protection tests are relevant to all products with ports. These methods ensure that products a) cannot be damaged by users accidentally connecting a plug to the wrong port, b) have adequate overload protection, and c) will not damage phones or appliances if the PV module voltage is higher than an acceptable port voltage.

Because the tests are potentially destructive, the protection tests are conducted using a sample size of one. This small sample size and the relative simplicity of the tests minimize the additional testing effort required for these tests. The protection tests would result in an increase in the overall test cost of approximately 3%.

5 Comments on the proposal to stop measuring the "usable surface area with illumination greater than 50 lux":

Respondents mostly agreed with the proposal to stop measuring the "usable surface area with illumination greater than 50 lux." Responses included:

- The metric is difficult to measure and is rarely used in advertisements.
- Usually the solar lantern is multi-functional and not only used as a desk lamp. The lumen output and light angle can be used to assess the light output in every condition.
- The useable surface area depends on the use of the product. I think we need to categorize and specify for specific uses that need more illumination.
- Users have complained that some products approved by Lighting Global provide inadequate light. This test should be continued and minimum values elevated.

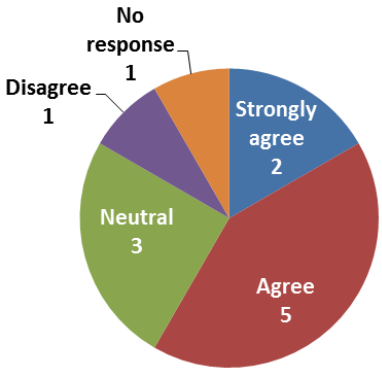

Figure 5. Do you agree with the proposal to stop measuring the "usable surface area with illumination greater than 50 lux"? Of the twelve respondents, seven agreed, three remained neutral, one disagreed and one did not respond.

RESPONSE: In an effort to reduce testing costs, we plan to no longer require measuring the "usable surface area with illumination greater than 50 lux." The test could still be conducted if necessary to evaluate advertising claims. However, the only required element associated with illuminance testing involves determining the "full-width half-max" angle, which is used to classify a light as being narrow, wide, or omni-directional.

Three of the respondents highlighted reasons why we recommend eliminating this test: the test is time-consuming, does not characterize all different methods of using a product, and is limited in that it only provides information about illumination greater than 50 lux. Different applications (e.g., reading, sewing,

detailed work) will require different levels of illumination, and the user would need more information than this single number to understand whether the product provides adequate light for their task.

One respondent suggested that the test should be continued because some products verified by Lighting Global provide inadequate light. Continuing this test would not address the issue of products providing inadequate light. While Lighting Global has always required that product performance be truthfully advertised, the program does not require a minimum light output or illumination to meet the Quality Standards. Prior to 2014, Lighting Global maintained the "Performance Targets," which allowed products with brightness and run time meeting the criteria to receive access to additional program benefits. However, based on stakeholder feedback that the performance targets were not well understood and the thresholds were difficult to set for a wide range of products, in 2014, the program decided to eliminate the performance targets and instead require that all products print the light output and run time on the product packaging so that consumers and others in the supply chain can easily compare product performance. Further, the light output of the product can be assessed according to the luminous flux test, which will still be required.

6 Comments on the proposed sample sizes:

Most respondents agreed with the proposed sample sizes, stating that the reduced sample size for larger products will help reduce shipping and testing costs.

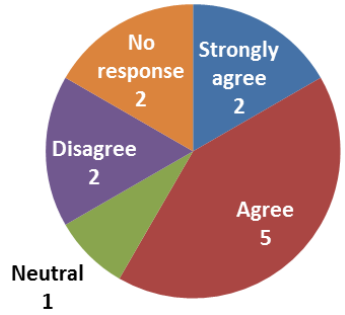

Figure 6. Do you agree with the proposed sample sizes? Of the twelve respondents, seven agreed, one remained neutral, two disagreed and two did not respond.

The two respondents that disagreed with the proposal fell on opposite ends of the spectrum:

- One stated that the sample size is too large and the required stock is too high, especially because testing occurs in the early stages of production when smaller quantities of stock are typically produced.
- The other implied that the sample size was too small. They stated that because Lighting Global is a world-recognized program that is used internationally and enables companies to avoid re-testing product performance for each new market or program, the tests should be conducted on a sufficient sample of products to be able to certify the system's performance.

Two others did not comment on the sample size, but provided the following comments:

- The general sampling procedure is not favorable. It would be preferable to provide the samples to the test lab. This would allow products to be verified at an earlier product phase (as is done in the Accelerated Verification Method).
- Random sampling from the market should also be conducted to ensure that the product quality is sustained.

RESPONSE: Based on the support for the proposed sample sizes, we will continue with the plan to require small products to be tested with a sample size of six and larger products to be tested with a sample size of four. Given that we received one comment that the sample size was too large and one that the sample size was too small, we may have struck an appropriate balance from a stakeholder perspective.

We will continue to consider different alternatives to the current sampling procedure to enable quality-verified products to be brought to market more quickly. This may include an expansion of the Accelerated Verification Method or other alternate pathways that address barriers such as the need for a large product stock. Additionally, we will continue our program of market check testing product samples that are selected directly from the market to ensure that products maintain their original quality over the 2-year verification period.

7 Comments on the proposed dividing line between product classes:

Feedback was mixed on how the product classes would be divided. Several respondents agreed with the proposed 15 W dividing line, stating that it was important to have a clear line to remove confusion. One manufacturer noted that 15 W was ok, but their SHS kits started at 10 W. Another manufacturer with a product line that ranges from 7 W to over 30 W stated that having a division within that product line would be difficult.

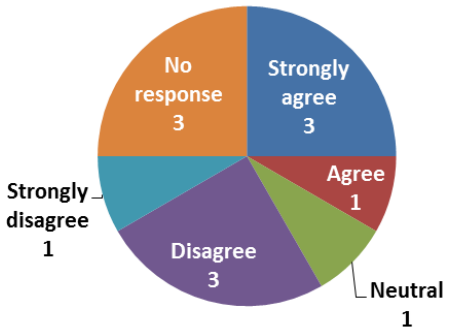

Figure 7. Do you agree with the proposed 15 W dividing line between product classes? Of the twelve respondents, four agreed, one remained neutral, four disagreed and three did not respond.

Those that disagreed felt that the dividing line was arbitrary and did not relate to a practical division between product types. One suggested that the divide instead be set at approximately 5 W, which they suggest generally separates products with a single unit from those that are component-based. [The respondent also suggested that 5 W is the dividing line between Tier 0 and Tier 1 products in the SE4All Global Tracking Framework; however, according to the June 2015 ESMAP report "BEYOND CONNECTIONS: Energy Access Redefined," the minimum requirement for Tier 1 products is 3 W and the product must offer mobile phone charging.]

Another respondent suggested that even 20 W systems sold as SHS kits are often disappointing to customers due to the energy limitations, suggesting that a dividing line based on wattage is inappropriate. They suggest that instead, the dividing line should be based on a characteristic of the system, such as whether the product can support appliances. The categories could be:

- Lighting kit: products that only have ports for light points or mobile phone charging
- SHS kit: products that have additional ports for appliances or can charge multiple mobile phones

RESPONSE: Since this initial proposal was shared, the Lighting Global team has discussed the dividing line with the Kenya Bureau of Standards (KEBS), which plans to utilize standards that are based on the Lighting Global Quality Standards and that reference a 15 Wp solar panel size. KEBS has expressed willingness to use 10 W as a division rather than 15 W once the SHS Kit methods are included as part of IEC 62257-9-5. Though this division is still somewhat arbitrary, we think a 10 W dividing line is more appropriate and will enable products 10 W and larger to use a reduced sample size to mitigate the additional in-kind and shipping costs associated with testing these products. Additionally, a number of products between 10 W – 15 W include appliances, and the reduced sample size will help to minimize testing costs for these more complex products.

Because we are concerned about the loss of accuracy with the smaller sample size, we are not comfortable extending the dividing line below 10 W. The suggestion to divide the product classes

according to characteristics is interesting and logical; however, we are concerned that there will be a number of cases in which the division will become difficult to determine. Given that countries and programs are adopting the test methods and harmonizing with the Quality Standards, we feel that we need to make the dividing line as clear as possible to avoid confusion.

Although we feel it is an imperfect solution, we currently propose to set the dividing line at 10 W based on the PV panel maximum power rating.

8 Comments on the proposed inclusion of additional Quality Standards for pico-products:

Only one respondent disagreed with the proposal to extend additional Quality Standards to pico-products, though several registered additional comments or suggestions:

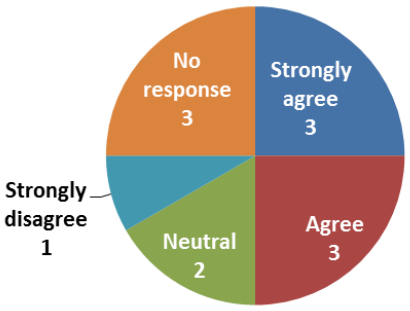

Figure 8. Do you agree with the proposed inclusion of additional Quality Standards for pico-products? Of the twelve respondents, six agreed, two remained neutral, one disagreed and three did not respond.

- One respondent stated that the requirement for lithium-based batteries to have overcharge protection for individual cells or sets of parallel-connected cells is too restrictive and that an equivalent technical solution should be allowed. For instance, they suggest that protection at the level of the whole battery pack along with a balancing circuit should be sufficient. The respondent also noted that the voltage thresholds for individual cells are technically difficult to achieve due to the precision required to maintain the cell between 3.65V (the target for charging voltage) and 3.7V (the overvoltage cut-off). To meet the requirements, they feel they would need to unnecessarily increase costs without providing an added benefit for the user.
- Another respondent proposed that the requirements for PV and other outdoor cables be extended to pico-products. Based on their experience, PV cables for some pico-products have been destroyed by UV light. They also note that some plastic covers of PV panels have decayed in a short time period.
- Another stated that the PV Overvoltage Protection test should be only applied if the battery can be disconnected by the user without opening the box with tools.

RESPONSE: Based on this feedback, we plan to extend the Quality Standards for Ports, PV Overvoltage Protection, and Circuit and Overload Protection to pico-products with ports. Additionally, the Miswiring Protection test would apply to all products with interchangeable connectors, and the additional Battery Protection for Lithium Batteries would apply to all products with lithium-based batteries.

Since originally receiving this feedback, we have discussed the issue raised regarding the individual cell protection for lithium-based batteries. We still plan to include the requirement but will clarify a few details. First, we currently do not have a method to test the individual cell voltage protection but will require the manufacturer to confirm (i.e. declare) that the battery has overcharge protection for individual cells or sets of parallel-connected cells in their description of the battery protection. We have not defined strict limits for the OVP of individual cells, but we believe the limits should be close to the maximum charging voltage. As the respondent noted, the voltage limit for the individual cells does not

need to be the same as the per-cell voltage limit for the entire pack; in fact, it would need to be higher, or else the pack would frequently get incompletely charged. For instance, for a lithium iron phosphate ($LiFePO_4$) battery with 4 cells in series and a cell balancing circuit, appropriate voltages may be:

- cell balancing limit: 3.6V
- overvoltage protection for the entire pack: 3.65 V/cell (actually 14.6 V for the pack)
- overvoltage protection for an individual cell: 3.9 V

As always, we will typically accept limits specified by the battery manufacturer in lieu of our recommended values. Our requirement is in line with the recommendations given in IEC 62133 for lithium systems:

> *5.6.2 Design recommendation for lithium systems only*
>
> *The voltage of each cell, or each cellblock consisting of parallel-connected plural cells, should not exceed the upper limit of the charging voltage specified in Table 4, excepting the case where the portable electronic devices or the likes have the equivalent function.*
>
> *The following should be considered at the battery pack level and by the device designer:*
>
> - *for the battery consisting of a single cell or a single cellblock, it is recommended that the charging voltage of the cell does not exceed the upper limit of the charging voltage specified in Table 4;*
> - *for the battery consisting of series-connected plural single cells or series-connected plural cellblocks, it is recommended that the voltages of any one of the single cells or single cellblocks does not exceed the upper limit of the charging voltage, specified in Table 4, by monitoring the voltage of every single cell or the single cellblocks;*
> - *for the battery consisting of series-connected plural single cells or series-connected plural cellblocks, it is recommended that charging is stopped when the upper limit of the charging voltage is exceeded for any one of the single cells or single cellblocks by measuring the voltage of every single cell or the single cellblocks.*

We appreciate the feedback that the requirement for UV protection for PV and other outdoor cables be extended to pico-products, but we do not intend to extend this requirement at this time. Given that many cables used for smaller PV panels have not been subject to this requirement, to avoid disrupting the market, we think a more gradual approach is warranted. We are working to determine appropriate standards for protection for outdoor cables for larger systems first. These requirements for SHS kits are documented in the Outdoor Cable Policy, and will begin to be enforced in early 2017. Once these are established, we will consider extending the same requirements to pico-products.

The PV Overvoltage Protection test is still applicable to products with batteries that cannot be disconnected by the user, primarily because the battery could still be disconnected by an automatic overcurrent protection mechanism (breaker, fuse, etc.). We have included two alternate methods for this test, one for cases where the battery can be manually disconnected and another for cases where the battery may be disconnected by an overcurrent protection device. This test requires minimal time and effort as it is only conducted on a single sample and may be conducted in conjunction with the output overload test.

9 Comments on changing the lumen maintenance threshold to 90%:

Most respondents were supportive of increasing the lumen maintenance threshold, stating that they agreed with the justification provided.

One respondent disagreed with the increased threshold, suggesting that a lumen maintenance of 85% is already enough for end user application. Another stated that increasing the lumen maintenance threshold is interesting, but the enforcement of appropriate warranty terms is more important.

Another respondent agreed with the proposal, but expressed concerns about the uncertainty in the measurement in cases where the photometer box is used (the photometer box is an apparatus used by some laboratories to conduct the lumen maintenance test).

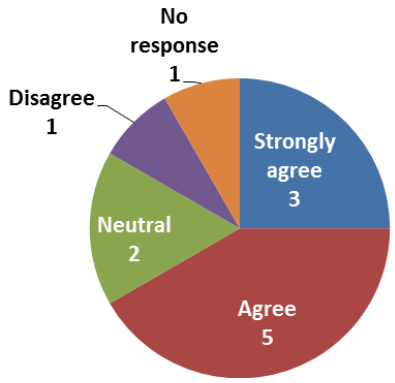

Figure 9. Do you agree with changing the lumen maintenance threshold to 90%? Of the twelve respondents, eight agreed, two remained neutral, one disagreed and one did not respond.

RESPONSE: Given the recent test data and trends in the LED industry, we feel comfortable increasing the threshold to 90% and do not feel it will substantially increase the cost of products for the consumer. To address the concern regarding the uncertainty in the measurement, we looked to past analysis conducted by our team on the accuracy of photometer boxes. In his master's degree thesis, "Analysis of low-cost testing methods for LED lumen maintenance of off-grid lighting products," Christopher Carlsen investigated the measurement error associated with photometer boxes and other devices used to assess lumen maintenance. He reports a measurement error of 7.5% associated with an individual measurement. However, when measurements are averaged, the error decreases. When considering the uncertainty of the mean, the error associated with the measurement is reduced to 3.75% for a sample size of four and 3.06% for a sample size of six. We think that this level of error is acceptable.

10 Comments on the proposed changes to the durability tests:

No respondents disagreed with the proposal to amend the durability tests. Two respondents suggested the addition of several more durability tests:

- Creating a test for ports/connectors that break when pulled sideways
- Assessing resistance to damage from dust or insects, especially with relation to switches
- Conducting durability and lumen maintenance tests at elevated ambient temperature to account for the fact that it is often over 40° C in many of the markets where these products are sold
- Assessing resistance to corrosion and other effects of high humidity environments

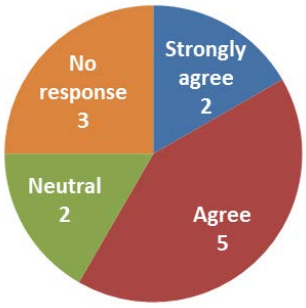

Figure 10. Do you agree with the proposed changes to the durability tests? Of the twelve respondents, seven agreed, two remained neutral and three did not respond.

- Determining if system is protected against voltage collapse. (Voltage collapse can occur if an constant power appliance draws a high current and causes the battery voltage to drop below the system's low voltage disconnect (LVD). When the LVD cuts the appliance off, the battery voltage may rise and allow the appliance to come back on for a moment, after which the appliance would cause the battery voltage to drop again. This could result in a dynamic in which the system would rapidly turn the appliance on and off.)
- Determining whether a port can charge a tablet computer
- Conducting a battery cycle test. The respondent noted that products are advertising battery life spans (some up to 7 years), while these advertising claims are not verified.

RESPONSE: Based on the positive response, we intend to amend the passing criteria for the durability tests as proposed. We have not yet determined the method for assessing the connector strain relief, but we will begin work to include this additional procedure for a future revision of the test methods. We will simultaneously investigate some of the other issues raised, including a test for connectors that break when pulled sideways and improvements to the switch test so that it more realistically evaluates switches in the field. To reduce the impact of dust and insects, we are considering increasing the physical ingress requirement to IP4X for all products but will not make this change without first seeking stakeholder feedback.

In the past, we have considered requiring tests, such as the lumen maintenance and other performance tests, be conducted at elevated temperatures or in high humidity environments; however, these tests would require expensive, specialized test equipment such as environmental chambers, which would significantly raise the cost of testing and limit the ability for many labs in smaller markets to perform the test methods. To avoid these cost increases, we have decided not to require tests at elevated temperature and humidity.

We have not noticed the issue of voltage collapse in our work with solar home systems, but we are interested to start exploring the issue and its impacts. Our understanding is that most charge controllers for larger systems include a switch-off delay or some form of hysteresis to avoid causing appliances to rapidly switch off and on; however, we do not know if smaller solar home systems typically include these measures. We will continue to explore this issue to determine if a standard or additional test is warranted.

We are working on ways to verify mobile device charging claims. Through the Energy Service Calculations, we expect to be able to provide an estimate of the energy available to charge a mobile phone or tablet, but we recognize there are additional elements, such as voltage, current and other device-specific requirements that must often be met to enable a phone or tablet to charge. We will provide additional details as we develop the test procedures and policy for assessing mobile device charging claims.

For several years, we have discussed the possibility of including a battery cycle life test, but we continue to believe that these tests are not appropriate for the Lighting Global program. Battery cycling tests are very expensive and time-consuming, with testing time potentially ranging from 6 to 24 months. A recent Tech Note entitled, Battery Testing for Off-grid Solar Products, describes the implications of battery cycling testing in more detail, along with our decision to not require cycle testing.

11 Other comments

11.1 Warranty comments:

We received three additional comments about the warranty for SHS Kits:

- One respondent noted that the quality of the warranty also needs to be considered, such as ensuring that the product is repaired or replaced in a reasonable timeframe. The respondent noted that issues commonly arise when distributors take too long to provide service or manufacturers do not fulfill their responsibilities to replace or reimburse faulty kits reported by the distributor or do not pay the distributor for the costs of delivering after-sales services due to a product problem under the responsibility of the manufacturer.
- The second respondent suggested that rather than having a staggered warranty of 3 years for the system, 2 years for the battery, a single warranty period of 3 years should apply to all the main system components. They suggest that this will be simpler for customers and distributors to manage and will address many issues related to the environmental impacts from low quality batteries. They note that most high quality lead acid and lithium-based batteries have adequate cycle lives to meet a 3 year warranty.
- The third respondent felt that the warranty requirement of 3 years for the system and 2 years for the battery was too long. They noted that the expected lifetime, the company warranty, and a minimum warranty requirement are not equal, where expected lifetimes and company warranty are often longer than the regulated minimum warranty period. They agree that PV modules can last more than 10 years and charge controllers can last 3-5 years, but argue that the regulated warranty period of most electronics as well as the warranty offered by established brands such as Apple and Samsung is one year or less. Essentially, they suggest that the minimum required warranty period should be, at most, 2 years and that manufacturers can then individually decide if they would like to increase the warranty period for their products.

  The third respondent also stated that including a capacity retention figure (the battery must provide >80% capacity after 2 years) in the battery warranty is not practical because it is not measureable to normal users and will only cause confusion.

  Further they suggested that the warranty period for USB charging adapters needs to be specified. Currently, they noted, the warranty period for USB charging adaptors appears to be 3 years, but this seems unnecessary as adapters are readily available in the market and often included with pico-products that only require a 1 year warranty.

RESPONSE: In the last three rounds of stakeholder feedback, we have received a range of comments on warranties, with some pushing for a longer period and some for a shorter one.

After considering the range of comments, we have decided to reduce the warranty period for SHS Kits to 2 years for the system and battery, and 1 year for appliances.[1] One of our goals with this change is to simplify the warranty terms for both companies and customers, particularly with the goal of aligning the warranty periods for the components which are dependent on each other, such as the charge controller and battery. We also reconsidered the core purpose of our warranty requirement. The warranty serves as a proxy to cover issues with products that may not be identified during testing and to ensure that customers have a degree of warranty protection. This warranty requirement is a *minimum* standard, allowing individual companies to offer longer warranty periods as desired and as per consumer expectations in a competitive market setting.

Though we have decided to reduce the warranty period, we want to revisit the question of appropriate warranty terms in upcoming stakeholder outreach. We acknowledge that the warranty issue is complicated and that having the same warranty requirements for a wide range of systems from 10 W to 350 W may not be reasonable. In the future, we may decide to set different requirements for the larger systems in this range.

We added the capacity retention figure for batteries based on stakeholder feedback from a prior respondent who noted that without a capacity requirement, one could claim that a battery that only provided 10% of its original capacity at 2 years would still meet the standard and not need to be covered by a warranty. We are aware of several companies including Nissan, Apple, Motorola and Northstar, which offer warranties that include capacity retention requirements of 70% or 80%. Further, the battery cycling tests in IEC 61247-1 define battery lifetime based on the number of cycles conducted before the battery provides 80% of its rated capacity. We do not expect that the battery capacity retention figure will typically be measured or disputed, but instead include the requirement to ensure that poor-performing, but still functional, batteries will be covered by the two-year battery warranty.

We do agree that USB charging adapters should be treated as appliances and are only required to be covered by a 1-year warranty. We will clarify this condition in the Quality Standards.

We recognize that how a warranty is honored is just as important as the warranty terms. However, as a global program, it is challenging for Lighting Global to verify and enforce how warranties are honored in the market. We do conduct routine market check testing to ensure that warranties are advertised appropriately and know that many local or regional programs delve more deeply into company's business plans and activities to verify that warranties are honored. Nevertheless, experience in the field indicates that warranty fulfillment is not consistent across markets or companies and needs to be improved. This is an issue that we plan to explore further going forward.

11.2 Sampling requirement:

One respondent requested that an easier sampling procedure be employed.

RESPONSE: We will continue to consider different alternatives to the current sampling procedure to enable quality-verified products to be brought to market more quickly. We feel that the Accelerated Verification Method offers one alternative, though we acknowledge that it is currently only available to a

[1] To be more specific, 2 years for the solar module, control box, cables, lights and main battery, and 1 year for lighting appliances that include their own batteries, non-lighting appliances and any charging adapters (USB or other) included with the kit. The warranty period for pico-products will not change and will remain 1 year.

limited set of eligible companies. Companies also have the option of conducting random sampling in stages; this procedure costs more and takes more time, but can offer an alternative for companies that do not typically keep large volumes of product in stock. For instance rather than requiring that 18 samples be selected from a stock of 500 units, the samples required for testing a pico-product could be collected by selecting 9 units from a stock of 250 one month, and another 9 from a new stock of 250 the next month. Further, in acknowledgement of the fact that larger products are typically more expensive and often produced in smaller batches, the minimum stock requirement is lower for SHS kits (which as we described above, we plan to define as products ≥10 W). While the sampling requirements for pico-products state that 18 samples must be selected from a stock of 500 units, the requirements for SHS kits state that 16 samples must be selected from a stock of 200 units. We are open to other suggestions of how to minimize the issues associated with sample selection while still ensuring the test samples are representative of the products in the market.

11.3 "Repairability" standard:

One respondent proposed that we include a repairability standard that would ensure products are designed to be able to be repaired if any key components break or need to be replaced. This standard would enable products to be used for a longer period of time, thus improving the value of a consumer's investment and reducing waste.

RESPONSE: In earlier versions of the standards, we had more strict requirements regarding repairability (primarily battery replaceablity). However, based on stakeholder feedback, these were replaced with the requirement that products clearly state A) whether or not their battery is replaceable and B) either how to repair the product or how the user can access service both during and after the warranty period.

One of the core principles behind the Lighting Global Quality Standards is that we should avoid, whenever possible, prescribing how products should be designed. There are challenges associated with developing non-prescriptive repairability requirements, and we therefore approach this issue with caution. While we are open to exploring the topic further, action on this front would involve efforts to identify non-prescriptive requirements and in-depth stakeholder consultation. In the interim, we do feel that companies who are interested in designing repairable products should be encouraged to do so. We are currently working to develop an Eco Design Note that provides a list of recommendations for the design and manufacture of repairable products. Our series of Eco Design Notes are available on the Lighting Global website here: https://www.lightingglobal.org/resources/eco-design-notes/