Stakeholder Feedback on Draft Minimum Quality Standards for Solar Home System Kits

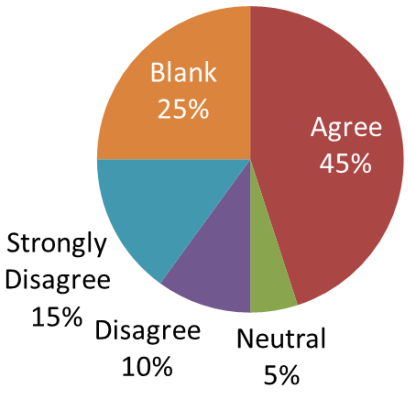
September 10, 2014

Thank you all for providing feedback on the draft Quality Standards for Solar Home System Kits. We received multiple comments from 20 different stakeholder organizations with a wide variety of connections to off-grid lighting. Respondents included 12 manufacturers, 1 industry/stakeholder organization, 4 distributors, 1 NGO, 1 development agency, and 1 financial institution.

Feedback has been organized according to the categories of Quality Standards. A synthesis of comments on each question or sub-topic is presented, along with responses from the Lighting Global team. While some 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.

The comments we received helped us to refine and improve the draft Quality Standards. A revised version of the Lighting Global Quality Standards for Solar Home Systems is presented following the list of feedback. In response to your suggestions of how we can improve the stakeholder process, we plan to host a joint webinar with the Global Off-Grid Lighting Association (GOGLA) on September 17th to discuss remaining questions and the plans for engagement around Solar Home System kits going forward. Details on the webinar are available on the Lighting Global stakeholder page.

1 Do you agree with the proposed eligibility criteria for solar home system kits to be covered under these Standards?



The majority of the comments we received were concerned with defining what types of solar home systems would be eligible for testing through our program. For brevity, many similar comments have been combined and all have been grouped into the three main categories below.

1.1 Concerns regarding "kits"

1.1.1 The framework should not be limited to kits.

Several respondents suggested that the scope should not be limited to kits. One cited concerns about the difficulties of packaging large components in a box together, and stated that the costs and delays associated with shipping batteries led them to source batteries locally and package components separately. Another stated that the framework should look at components, especially charge controllers, as companies will want to assemble their own components for these larger systems. They noted that many successful solar home system organizations in Bangladesh have relied on component-based systems rather than plug-and-play kits.

RESPONSE: For our first step into the solar home system market, our initial focus will be on plug-and-play kits. As a global program, our testing has been designed to assess products at the level of the manufacturer, rather than at the point of sale. In the case of solar home systems, many are sold as individual components that require a trained technician or sales person to appropriately select and design a complete system for an individual customer. As we cannot evaluate the quality of this design process at the point of sale, we plan to focus on kits that have been pre-designed and packaged as a kit by the manufacturer.

The case of Bangladesh is an inspiring example of widespread and rapid adoption of solar home systems; however, our understanding is that a driving force behind this market is the requirement of a serviceable warranty on components and installation (5 years for the battery, 20 years for the panel, 1 to 3 years for the charge controller, and 3 years for the lights). As a voluntary global testing and verification program, we do not have the mandate or the on-the-ground capacity to enforce such a policy and must instead rely on other methods to improve consumer confidence in the market.

That said, we recognize the value to the industry of evaluating the quality of key components such as PV modules and charge controllers. With this in mind, we are assessing the potential to use the test methods that we are developing (or adopting, since many of the test methods already exist) for complete kits to also evaluate individual components at a later date in the future. We will follow up with additional information about this in the coming months. We do not anticipate changing our initial focus on kits, but there may be possibilities for the program to additionally cover some individual components and kits that are sold without batteries in the future.

1.1.2 Installation is important and often required

Several respondents noted that even with solar home system kits, there is a need for trained installers. One respondent cited safety issues regarding working with 12 V DC and country regulations requiring trained technicians to work with higher voltages and mount PV modules on rooftops (for example,

UNBS and ERA regulations in Uganda). Another noted that assisting clients with installation proves valuable to clients. Additionally, proper positioning of the PV module is critical to product performance and is difficult to communicate in an installation manual.

RESPONSE: With our definition of plug-and-play kits we do not intend to exclude the use of technicians to help properly install a solar home system kit, but rather are suggesting that the kits we are covering are ones that could be installed without an electrician or technician. Electrical connections should be safe and straightforward, and instructions should be clear. We recognize that having trained sales personnel or technicians assist customers with properly mounting PV modules, hanging cables and understanding how their system functions greatly increases the likelihood of these systems functioning for their full intended lifetime. We also recommend that companies encourage their distributors to provide this support for customers, but again, at the global level, we have very little control over evaluating the availability or effectiveness of this installation support.

We are still working to define some elements related to the definition of "plug-and-play" for the purpose of the Lighting Global quality standards for SHS. One key element we may change at a later date relates to the types of allowable electrical connections (e.g. should systems that involve simple electrical connections, like screw terminals, that do still require the use of a screwdriver, be included or excluded). Another issue is determining how to evaluate instruction materials, given that a product may be sold to customers with varying levels of literacy and across countries and regions involving many different languages.

1.1.3 It is unclear whether the framework covers appliances

Several respondents noted confusion over whether the framework included appliances (lights, radio, TV, fans…), while two respondents recommended that appliances not be covered by the Quality Standards.

RESPONSE: In our proposed framework, we do plan to include test methods to assess the voltage range, power consumption and basic safety of any appliances that are included with a kit. Appliances would also be subject to durability and ingress protection testing based on their classification as a portable, fixed indoor or fixed outdoor component.

An appliance is considered to be included with the kit if it is marketed and sold as part of the complete kit. Appliances that are sold separately or as optional accessories may be tested at the discretion of the manufacturer.

1.1.4 Appliance cables should be included

A respondent noted that it should also be stated that cables and accessories necessary for the installation of lighting and other appliances should be included.

RESPONSE: We agree that if appliances are included, an appropriate set of cables and connectors should be included as well. We have added this to the product description for the Quality Standards.

1.1.5 Concerns about Product Family policy

One respondent noted the "Framework for Testing Product Component Families" states that all configurations within the family will be included in the "spec book". They further note that the benefit of interchangeable components is that the number and configurations of kits is not finite, so listing all possible kits is not practical.

RESPONSE: We do not intend for all configurations within a family to be included in the "Spec Book" and will clarify this in the policy document. The "Spec Book" will contain Standardized Specification Sheets (SSS) for one or more tested configurations and a component-level SSS page that lists all of the components in the product family.

1.2 System Size

1.2.1 The proposed PV module wattage limits are confusing

Many respondents did not see the reasoning behind our proposed upper limit for system size: "If multiple solar modules are included, the combined peak power rating is between 10 and 100 watts, while the peak power rating may exceed 100 watts if only a single module is included in the kit."

RESPONSE: Our intention was to cover the majority of plug-and-play systems on the market while maintaining a reasonable upper bound to ensure we could still use low-cost test methods to safely assess the products. Our initial review of existing plug-and-play kits available in the market (based on a combination of internet research and engagement with kit producers) indicated that only 1-2% of these kits had solar PV modules or arrays that exceeded 100 peak Watts. Thus, our information suggested that an upper bound of 100 Watts would cover the majority of the eligible systems. After some initial discussion with stakeholders and IEC Technical Committee 82 representatives, we decided to consider expanding the framework to allow larger systems only if they were based on a single module. The logic here was that this would set a natural upper bound based on the largest available modules that could be used. Based on the feedback we have received to date, this flexible upper bound may lead to confusion, so we propose that for the upcoming initial test round, the upper bound for systems will be 100 peak Watts.

That said, we are interested to continue discussing whether we could raise this upper bound while still ensuring that reasonably low cost laboratory equipment could be used to test the systems. One proposal would be to set a higher upper bound based on a current limit rather than a power limit. A current limit of 8 A at any point in the system would ensure that typical laboratory equipment could be used to test the systems, while still covering relatively high power solar home systems. A product with a nominal system voltage of 12 volts could have solar PV modules with rated maximum power point voltage of over 16 volts and maximum power on the order of 120 watts, while higher voltage systems would have higher wattage limits. The actual upper bound for PV module power would depend on maximum power point voltage and current of the specific module included in the system.

We have also considered defining systems by the type of energy service they offer, rather than with a technical wattage or amperage limit; however, a less technical definition often results in more subjective and less defensible decisions.

1.2.2 Plug-and-play connectors will limit systems to less than 100 W

One respondent noted: Commonly available DC sockets for plug-and-play type systems have a maximum rating of 5A which would limit system size considerably below 100W. The quality of these connectors also becomes an issue and testing procedures should be considered.

RESPONSE: We acknowledge that commonly available DC sockets are often rated for 5 A (or lower), but also recognize that there do exist higher ampacity connectors and systems that operate at higher than 12 V. We agree that connectors included in a system should be rated to safely and effectively handle the current that may pass through them during normal system operation. We plan to ask manufacturers submitting products to provide a signed declaration that all wires, cables and connectors in their systems

meet the ampacity requirements of the expected current. We are also assessing approaches that could be used to evaluate whether the connectors in a system have been appropriately specified. Further, as mentioned above, one element of the definition of plug-and-play kits we may change at a later date is whether simple electrical connections, like screw terminals, that do require the use of a screwdriver will be included within the definition of plug-and-play. There are many types of screw terminals available that are designed for currents greater than or equal to 8 amperes.

1.2.3 Systems should not be limited to 100 W

Though some respondents felt that the 10 W- 100 W range and focus on DC loads was appropriate, several felt that systems should not be limited to 100 W and should cover AC systems as well. In experiences cited from Malawi, Sierra Leone, Guinea and Liberia, higher wattage systems are common and desired by many consumers.

RESPONSE: As noted above, we are maintaining the 100 W limit for now, but considering possibilities to revise the proposed limits for system eligibility for the final framework. These changes would allow higher-power systems to fall within our framework in certain cases.

We do not plan to include AC systems within the Lighting Global framework at this time. The safety issues associated with the higher voltages (e.g. 230 VAC) associated with common AC-based systems create challenges for their inclusion in a framework focused on plug-and-play kits that can be installed by customers without the assistance of a technician.

1.2.4 120 V DC output

Several respondents voiced concerns about the safety and complexity of allowing 120 VDC outputs.

RESPONSE: We agree that inclusion of higher voltage outputs in plug-and-play kits creates safety challenges. In response to these concerns, the Lighting Global quality assurance program will, at least initially, restrict systems to nominal voltages that do not exceed 50 VDC.

1.3 General

1.3.1 Lighting Global should not address solar home systems

While many respondents reacted positively to our plans to expand to cover solar home system kits, two respondents felt that Lighting Global should not be extending support to solar home systems. Both felt that because there are existing specifications, standards and norms covering solar home systems, the need for intervention is not as critical as it was for pico-solar products. One respondent further voiced that involvement in the sector would create an unwanted barrier and confusion in the market, and that the development of the solar home system market is better left to the industry.

RESPONSE: Our move into this sector has been prompted in large part by requests from manufacturers, distributors, and financial institutions that have encouraged us to expand our quality assurance framework to include solar home system kits. While we agree that there already exist many relevant standards for components of solar home systems, no comprehensive quality assurance framework is in place. As noted below, we plan to reference existing test methods where appropriate.

1.3.2 Need to assess existing standards

One respondent asked if it was "clearly checked which existing solar home system standards and specifications are applicable or even conflicting with the planned ones?"

RESPONSE: As we develop our quality assurance offering for solar home system kits, our team is working closely with representatives from the IEC. We anticipate that the framework will ultimately be adopted by IEC in the form of an IEC technical specification in the 62257 series. Our revision would reference many of the test methods from IEC TS 62257-9-5 (the methods we currently use for pico-solar systems / off-grid lighting products) and – where applicable – reference other already established test methods from documents such as IEC 61215. While we would effectively be introducing a new set of standards into the market, by focusing on solar home system kits, which are not currently assessed at the system level, we believe we would be providing a desirable service.

1.3.3 Clearly define manufacturer

One respondent asked that we more clearly state that the "manufacturer" is the company selling the product, not the actual manufacturing partner who many companies will want to remain confidential.

RESPONSE: This comment raises an important point. We have previously used the term "manufacturer" to refer to a company that designs and manufacturers a product, either by their own activities or by contracting a third party, and that either markets the product under a recognized brand name or allows other companies to market the product under a brand name. By this definition, a company that is not involved in design or manufacturing decisions would not be classified as a "manufacturer." We recognize, however, that this is not the only way to define the term manufacturer, and as a program, we may decide to change the word that we use to refer to companies whose products we test.

1.3.4 Need to support small, local manufacturers

One respondent expressed the desire for Lighting Global to provide incentives for young entrepreneurs, small businesses and local initiatives. They noted that opportunities to meet and discuss potential activities and contributions would be helpful.

RESPONSE: In our development of the quality assurance program for both pico-products and solar home systems, we have sought to keep the cost of testing and otherwise engaging with the program within reasonable bounds in order to ensure broad access. Nonetheless, we recognize that the cost of product testing and engagement can represent a significant expense for some of the smaller companies that are involved in the market. Over the coming years, the Lighting Africa, Lighting Asia and Lighting MENA programs will broaden their scope to more deeply engage in more countries across Africa and Asia. We hope that these country-level activities will provide a number of local companies and organizations additional opportunities to engage.

1.3.5 A standard may not cover special functions

One respondent noted that it can be difficult to cover special functions, which are often unique selling points of products, with a broad standard.

RESPONSE: We cannot attempt to address all special functions with the Quality Standard, though we do try to assess the safety, durability and truth-in-advertising aspects of all products. Marketing and promotion of special functions is left to the manufacturers and distributors.

1.3.6 Full range of energy access options should be promoted

One respondent noted that efforts and investments should not be focused solely on pico-solar or kits smaller than 100 W, but rather customers should be presented with a full range of energy access options to choose from. Customers would then be able to choose which options they prefer and can afford and would not waste time or money on purchasing smaller systems if they can afford something larger that

better meets their needs. The concept of 'climbing the energy ladder' may not be applicable to many households who do not necessarily need to start at the bottom of the ladder.

RESPONSE: We agree that efforts should be made to provide access and education about the wide range of options available for rural electrification. We also feel that many manufacturers, distributors and organizations are working toward this goal, including the Sustainable Energy for All (SE4All) program, a joint initiative of the United Nations and the World Bank Group. The Lighting Global program does not intend to dissuade consumers from purchasing larger solar home systems or otherwise gain access to electricity, but is focused improving the market for low-cost opportunities to provide electricity with renewable energy. As part of this effort, our quality assurance program is currently focused on pico-lighting products and is expanding to solar home system kits.

1.3.7 Need a clearer picture of quality assurance across the spectrum

One respondent noted that there should be a clear description of the quality assurance frameworks that cover the energy access spectrum, from pico-products to solar home systems to minigrids.

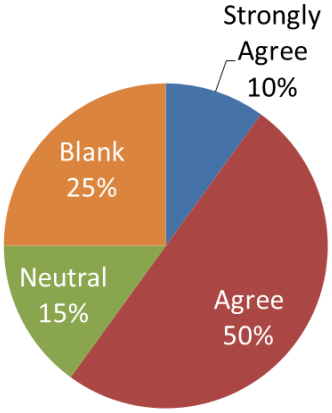
RESPONSE: We agree that a clear outline of existing quality assurance frameworks across the range of energy access options would be useful. There are a number of different standards and frameworks that apply to components that are used in both solar home systems and mini-grids, but very few that address system-level design or performance. Additionally, the existing component-level standards are often applied inconsistently across programs and across countries. The Lighting Global quality assurance framework is used widely for pico-products, and we are working to develop a similar framework for solar home system kits. In developing the current solar home system kit framework, we are engaging closely with relevant organizations such as the International Electrotechnical Commission (IEC). We would be interested in engaging with other organizations to develop an outline of quality assurance frameworks that apply to the energy access spectrum to provide clarity on the subject and help guide future activities in the sector.

1.4 Improve clarity of text

One respondent offered helpful suggestions on improving the clarity of the Quality Standards by using terms more consistently and reducing the use of vague or generalist statements.

RESPONSE: We thank the respondent for their suggestions. We have revised the draft Quality Standards to use terms more consistently, rather than, as noted in the comment, referring to a solar module, then a PV module, and then a solar panel. We have chosen to use the term PV module throughout, though recognize that some of our communications may instead refer to solar panels, depending on the audience we are addressing. We have removed some of the generalist statements in the text; however, some were maintained in cases where details are provided in the test methods and not required to be repeated in the Quality Standards.

2 Do you agree with the proposed Truth-in-Advertising standards?



We received broad agreement with the Truth-in-Advertising Standards, though one respondent suggested strengthening the allowed tolerance, one asked about our assessment of runtime, and one was concerned about the use of neutral packaging.

2.1 Make the Truth-in-Advertising tolerances stricter

One respondent requested that the Truth-in-Advertising tolerances be tightened to allow a deviation of no more than 10% at least on the low side.

RESPONSE: We plan to use the same tolerance of +/- 15 % that we have used for pico-products as this tolerance to accounts for deviations between samples, among test labs and random variation.

2.2 Runtime assessment

One respondent noted that runtime values will depend on what appliances were used and asked how we plan to address this issue.

RESPONSE: We agree that this is a complex and challenging issue. We are working on developing a standardized method of estimating the number of watt-hours (Wh) available for use after a single day of solar charging. This method would account for efficiency losses throughout the system. Based on this calculation, we would then be able to check manufacturer's claims for runtime using the appliances that they include with their kit, that they specify in advertising, or – if needed – using standard appliances. This assessment framework is one of the elements of the QA effort that we will be developing and evaluating during the first round of product testing.

2.3 Concern regarding use of neutral packaging

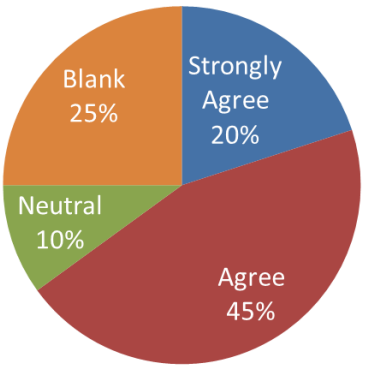
One respondent noted that they do sell plug-and-play kits, but often, as part of their service install the PV modules on the roof and perform the cabling. In these cases, the system comes with neutral packaging. They note that relevant features and performance metrics would be presented on other materials, such as a flyer, manual or contract.

RESPONSE: As noted above, these kits would still meet our definition of plug-and-play even if customers are offered the option of having the system installed. Our truth-in-advertising requirements extend to any specifications presented to the customer, whether they are on the packaging, in a manual or on advertising materials such as a flyer or webpage. If a product with neutral packaging were being sent for testing, we would request the manufacturer also provide us with any advertising materials they intend to use with the product.

We should also note that, in consultation with GOGLA, we are in the process of developing an on-the-box performance reporting requirement for pico-solar products. We will consider the issue of neutral packaging when developing this policy. It is possible that the framework will be extended to solar home system kits in the future.

3 Do you agree with the proposed Lumen Maintenance standards?

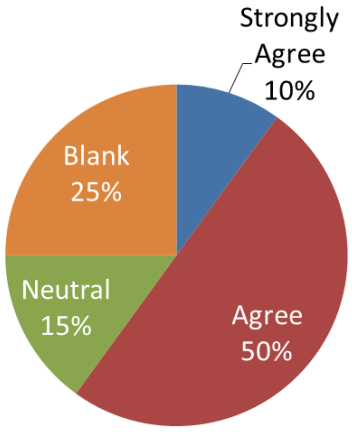
There was broad agreement with the proposed lumen maintenance standards. Only one respondent recommended that we align the lumen maintenance threshold with that for pico-products by requiring that "greater than or equal to 85%" of the specified light output remain after 2000 hours.



RESPONSE: We do not plan to accept this recommendation as we have purposely strengthened the lumen maintenance requirement to "greater than or equal to 90%" to account for the longer expected lifetimes of the larger solar home system products.

4 Do you agree with the proposed Health and Safety standards?

Most respondents agreed with the proposed Health and Safety standards. Some raised concerns about the proposed requirements for fuses, while others asked clarifying questions or proposed additional standards.



4.1 Concerns about spare fuses

Several respondents raised questions about requiring fuses to be labeled and spare fuses to be supplied. One respondent stated that automatically resettable fuses do not need to have the size or value marked on the product. Another mentioned that their fuse could not be easily replaced by the user without voiding the warranty, making it inappropriate to include spare fuses. A third respondent stated that their product has electronic overcharge and overcurrent protection for normal use, but fuses are used to protect the system from unintended use, such as when a user plugs a cable into an incompatible device. They asked if they would still be required to provide spare fuses in this situation.

RESPONSE: We agree that products with automatically resettable fuses do not need to have the size or value of the fuse marked on the product and do not require the inclusion of spare fuses. Other resettable forms of over-current protection would also be acceptable. We have revised the Standards to clarify this point.

We also feel that it is imperative that products be protected from irreversible damage due to an overcurrent and that the protection mechanism should be easily resettable or replaceable by the user, or must automatically reset. We have amended the Standards to clarify this point. In a case where the end-user is not intended to be able to replace the fuse, it would be necessary for customers have a reasonable way to obtain repair services in the event that the over-protection is tripped. Because our program cannot monitor the availability of after-sales service, to meet the Standards, an easily resettable or replaceable form of circuit protection would need to be used. We have revised the Quality Standards to clarify that we do expect products to be protected from overcurrents, even if the cause of the overcurrent is an unintended use. In cases where replaceable fuses are used to protect the system from unintended uses, at least one spare fuse should be included.

4.2 Provide clarity on Standards for AC-DC charger

One respondent asked for more information regarding the standards for the AC-DC charger.

RESPONSE: The standard for AC-DC chargers requires that any charger which is included with the product carries approval from a recognized consumer electronics safety regulator such as UL or similar. We do not intend to test AC-DC chargers as part of regular qualification testing, but do require manufacturers to provide documentation to verify that the charger carries a relevant safety approval. The program may choose to evaluate whether products with AC-DC chargers meet the relevant safety requirements associated with the certificate that they provided (e.g. UL, etc.) in the context of market check testing.

4.3 Components should meet RoHS and REACH

One respondent suggested that electronics and other components like lamps should meet existing international standards of RoHS and REACH.

RESPONSE: This topic was raised during last year's stakeholder process and further discussed at the GOGLA symposium in April 2014. Our team is researching the implications of requiring companies to comply with RoHS and REACH, both in terms of costs to a company and methods of monitoring/enforcement outside of the European market. Currently, for both the pico-product framework and the proposed framework for solar home system kits, if a product has met RoHS and REACH requirements, they may request that this compliance be listed on the product's Standardized Specification Sheet.

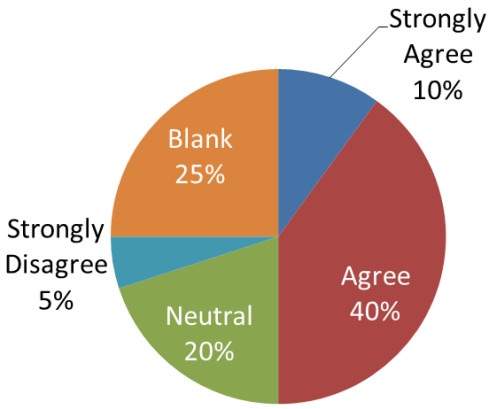
4.4 DC-DC Ports

One respondent noted that some devices, such as laptops, are powered by DC-DC converters which are often poor quality and should be subject to minimum standards.

RESPONSE: We do intend to assess the functionality, voltage range and efficiency of DC-DC converters included in plug-and-play SHS kits within the scope of our truth-in-advertising standards. We may determine that additional standards need to be applied in relation to DC-DC converters and would be interested in feedback in this regard. We are still in the process of determining how to best calculate and communicate a standard performance metric (such as Wh/solar-day) for SHS kits, but we anticipate that efficiencies of DC-DC converters will be included in this metric.

5 Do you agree with the proposed Battery standards?

While most were in general agreement with the proposed Battery standards, one respondent strongly disagreed. Two respondents provided additional suggestions on how these standards could be improved.



5.1 Require replaceable batteries

One respondent stated that batteries need to be field-replaceable with a minimum of tools and replacement batteries should be a stock item.

RESPONSE: We agree that these are good practices to enable products to last beyond the lifetime of a single battery, and have added to the Quality Standards that batteries must be field replaceable. (Note that product designs in which opening the battery compartment voids the warranty would still be permitted). However, we historically have not mandated how companies manage their after-sales service beyond offering a serviceable warranty. Further, we do not have the ability to monitor the supply chain to ensure that batteries are kept as a stock item. Though ideally replacement batteries will be available, the Standardized Specification Sheet for a product will report key battery metrics to enable consumers or technicians to identify a proper replacement battery.

5.2 Require battery cycling tests and lifetime curves

The same respondent suggested that we specify a minimum reduction in capacity after n charge/discharge cycles and specify battery lifetime curves over a range of ambient temperatures, including high temperatures common in tropical areas.

RESPONSE: We have considered including a battery cycling standard, but have decided that the test would be too expensive and equipment intensive to include in our testing regime. Should a different program decide to require a battery cycling test, a procedure is included in the draft test methods.

Though we do not create or specify battery lifetime curves, due to the cost and time required, the required battery durability test addresses a similar issue by ensuring that the battery capacity has not substantially decreased after being stored under adverse conditions for 30 days.

Further, batteries used in many products are produced by third-party battery manufacturers and come with a battery specification sheet that may be requested by distributors or organizations. These specification sheets will often include battery cycling results and lifetime curves.

5.3 Require use of deep cycle batteries and IEC 61427

Another respondent suggested that flooded batteries should not be permitted and that deep cycle batteries should be required. They noted that IEC 61427: *Secondary cells and batteries for renewable energy storage*, should be used for testing.

RESPONSE: As high quality deep cycle flooded lead-acid batteries are widely available and used in many solar home system kits, we do not plan to restrict their use at this time. We do however agree that batteries used in solar home systems should be designed for deep cycling; automotive or SLI (Standard, Lighting and Ignition) batteries typically have short lifetimes in SHS applications. We are investigating whether these battery types would meet the requirements associated with the battery durability test that we plan to utilize when evaluating the systems.

In development of our draft test methods, we are reviewing IEC 61427. As noted above, we feel that a battery cycling test would be too expensive and equipment intensive for our test regime and would therefore not adopt this portion of IEC 61427, but will likely adopt other relevant portions of this publication.

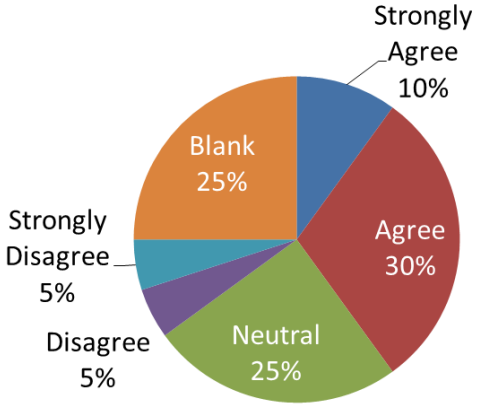
5.4 Sizing

The same respondent asked if we would include any requirements for sizing and suggested that we should set a minimum standard for battery size versus daily consumption. They note that industry standard prescribes sizing storage for at least 3 days of usage. They further asked if sizing were to be required, what sun-hours would be used and whether it would be based on the lowest or highest sun month.

RESPONSE: When setting the Quality Standards, we have tried to avoid prescribing design or performance parameters, except those necessary to protect consumers to ensure safe, durable products that will perform as advertised. We agree that sizing is critical to the design of a good solar home system and that think that including at least 3 days of battery capacity is often a reasonable benchmark. However, we do not plan to set a requirement for sizing. We do plan to report relevant measurements to the market to enable buyers to make educated decisions; we anticipate that these metrics will include solar module rated power, battery capacity, watt-hours available from a fully charged battery, and watt-hours available after a single day of solar charging. Other metrics may also be included.

6 Do you agree with the proposed Quality and Durability standards?

Respondents expressed a variety of opinions regarding the proposed Quality and Durability standards; some suggested additional standards, while others recommended alterations or requested clarity of the proposed standards.



6.1 Concerns about the drop test

Several respondents voiced concerns about the drop test; one noted that large components should not be expected to be functional, while another suggested a method of considering the mass of the Device Under Test (DUT) in the drop test. They suggest adapting standards from ISTA 1A/2A and MIL-STD-810 (procedure IV-Transit Drop), which modify the drop height based on the mass of the DUT. Their recommended approach would be to select a standard for impact energy and a maximum drop height (to avoid impractical heights for lightweight objects). This would set the required height for the drop based on the DUT's mass: [height] = [Energy]/([mass]*9.81) Using this approach with a desired energy of 25 J (as one example) - a 2.5 kg DUT would need to survive a drop height of 1 m whereas a 4 kg DUT would need to survive 0.64 m

RESPONSE: The drop test will only be applicable to portable components. Portable components are inherently portable and generally contain an internal energy source/battery. For example, a solar home system kit may include a portable light with a battery that can be charged from the main system battery. Components that are designed for permanent or semi-permanent mounting and use in place are categorized as either fixed indoor or fixed outdoor components, and would not be subject to the drop test. We imagine that most products of sufficient mass would not be considered to be portable and would not be required to pass the drop test. Further, while we understand the concern that the impact experienced by a DUT will differ based on mass, we have conceptualized the drop test from a consumer-centric perspective in which a product, regardless of mass, falls from a table top or a typical carrying height and is expected to still function. That said, as we develop the test methods, we will consider the above proposal and potentially include an approach to adjust the drop height for heavier portable products.

6.2 Cable length

Respondents shared mixed views on the cable length requirement. Two respondents suggested that a minimum cable length is outside of the scope of the Quality Standards and should be left as a design decision. They noted that in some cases, a shorter PV module cable could still meet a customer's needs and would minimize efficiency losses and be lower cost. A different respondent noted that minimum cable lengths for other cables in the system (e.g. for connecting lamps to the controller) were omitted and that a 5 m PV cable is rather short.

RESPONSE: Though we recognize that the minimum cable length is a design decision, we feel that a minimum length is required to ensure that customers will reasonably be able to appropriately place a PV module outside while being connected to any components meant to remain indoors. When designing custom solar home systems, shorter cables may be appropriate on a case-by-case basis, but as we are currently discussing standards for solar home system kits that come with pre-packaged cables, we feel that specifying a minimum cable length is appropriate.

We do wish to clarify both here and in the Quality Standards that products may utilize a shorter cable, but any components connected to that cable will be subject to different ingress protection (IP) requirements. We have revised the Quality Standards to state that,

> Cables must be at least 5 m long when connecting a "fixed indoor" or "portable separate" component to the PV module or any other fixed outdoor component. Otherwise, components will be considered "fixed outdoor" or "portable integrated."

This statement is based on how we plan to define the product categories in the test methods document:

a) Fixed indoor components are not inherently portable and are used indoors. If a fixed indoor component is connected to a component that is intended to be used outdoors (such as a PV module), the cable connecting the two components shall be sufficiently long to allow typical users to place the outdoor component outdoors in an appropriate location while the indoor component remains indoors. Otherwise, the fixed outdoor category shall apply.

b) Fixed outdoor components are not inherently portable and are intended to be used outdoors, or are connected to components intended to be used outdoors by a cable of insufficient length to allow the component in question to be placed indoors by a typical user. Fixed outdoor components may contain integrated PV modules; however, PV modules without additional components form their own category.

Portable components are further classified by the presence or absence of an integrated PV module:

c) Portable separate components are portable, with a battery and load permanently or temporarily joined. If the component must be connected to a fixed outdoor or portable integrated component or a PV module, the cable connecting the two components shall be sufficiently long to allow a typical user to place the outdoor component outdoors in an appropriate location while the indoor component remains indoors; otherwise, the portable integrated category shall apply.

d) Portable integrated components are portable and are charged with a PV module that is integrated in the casing or is otherwise designed so that the whole component shall be left outdoors to charge via the PV module. This includes portable components that must be connected to fixed outdoor or portable integrated components, or a PV module, by a cable of insufficient length to allow the component in question to be placed indoors by a typical user. Portable integrated components may contain PV modules; however, PV modules without additional components form their own category.

6.3 Outdoor rated cables

Several respondents asked for clarity on what is meant by outdoor-rated and UV-resistant cables and what would be required of manufacturers to prove that their cables meet the requirement.

RESPONSE: Where applicable, we plan to ask manufacturers to provide documentation that indicates that their cables meet the necessary requirements. We do not intend to test whether cables are outdoor-rated or UV-resistant during qualification testing, although it is possible that the program would choose to evaluate whether a product meets the ratings claimed in the documentation that they submit in the context of market check testing.

Our proposed requirements are as follows: PV cables must meet UL 4703, TÜV 2 PfG 1169/08.2007 or similar standards. Other power cables used outdoors should be tested or certified for outdoor use (i.e. the cable type has undergone sunlight resistance according to UL 44 Section 5.15.2, ISO 4892-2 Method A, UL 1581 Section 1200 (XenoTest), or HD 605/A1, or similar, as well as some form of wet/damp heat testing). Manufacturers will be asked for evidence that cables have met these requirements in the form of certificates or other testing documentation.

6.4 Specify thickness of cables/wire size

One respondent noted that no standards were included for wire gauge / thickness of cables.

RESPONSE: We agree that wire size is important, both for safety and to minimize resistance and resultant efficiency losses. We believe that efficiency losses will be accounted for in the performance metric we are designing, but do feel that a standard should be included to ensure wires are large enough to safely handle the currents they are intended to carry. We will add a requirement to the Quality Standards that the ampacity of all cables used in the system is adequate for the maximum current, and require manufacturers submitting products to provide a signed declaration that all wires, cables and connectors in their systems meet the ampacity requirements of the expected current.

6.5 Specify strain relief test

A respondent suggested that the Quality Standard should detail the conditions of the strain relief test.

RESPONSE: The conditions of the strain relief test are detailed in the test methods. In the test, the cable must securely hold a 2 kg weight for 1 minute at an angle of 0°, 45° and 90° relative to the direction from which the cable protrudes from the component. We do not plan to include this level of detail in the Quality Standards as these conditions are already specified in the test methods.

6.6 Air cooling of module

One respondent noted that a requirement should be included for the distance between the PV module and the roof to allow for air cooling. They note that an adequate distance can minimize efficiency losses as well as increase the lifetime of the module.

RESPONSE: We agree that proper mounting of a PV module is essential for optimum system performance. However, we do not plan to include a mounting distance in the Quality Standards at this time, but may require this element to be included in the installation and user manual.

6.7 Define an ambient operating temperature range

A respondent recommended defining an ambient operating temperature range to ensure that systems do not solely meet the performance requirements at 25° C.

RESPONSE: We do test PV modules at both 25° C and closer to an operating temperature of 50° C. Also, the battery durability test requires storing batteries for 1 month at temperatures between 30° C and 60° C depending on the battery chemistry. Other tests are carried out at ambient lab conditions.

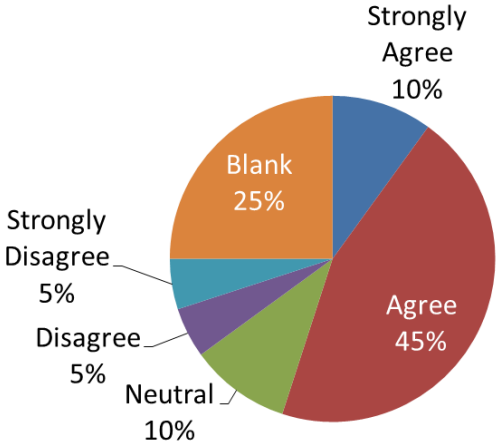
6.8 Sustainability and accelerated aging

One respondent noted that the standard does not appear to say anything about sustainability and suggested there need to be accelerated aging tests, to ensure that products will still be viable in 5 years.

RESPONSE: We do not plan to include accelerated aging tests, aside from the battery durability test, in this first round of testing. We are concerned that many accelerated aging tests involve test methods that are expensive to implement, but we are interested to investigate tests of key durability metrics that can be implemented at a reasonable cost with test methods that can be completed in a reasonable amount of time.

7 Do you agree with the proposed Consumer Information standards?

While most respondents agreed with our proposed Consumer Information standards, two respondents disagreed with our proposed warranty standard and six provided comments regarding the warranty length. Two



others commented about the user manual, the presentation of consumer information and the importance of after-sales service.

7.1 Warranty length

The following comments were received regarding the proposed warranty; note that some have been paraphrased for brevity, clarity and anonymity.

Comments from manufacturers:

-If a minimum warranty is required for accessories, I'd suggest 1-year on the accessories.

-We have extended our warranty from one year to two for all our solar products. Although the products are designed and manufactured to last much longer, servicing a three year warranty as proposed is not practical and would be a prohibitive issue for us.

-Fully agree with the 3 year warranty on the system. The 2 year warranty on the battery might be a bit more difficult, especially if it is "misused." In our experience battery manufacturers rarely extend a 2 year warranty, so we would have to take this on ourselves.

-The proposed warranty periods are too short. We would prefer a 10 year warranty for PV modules and 4 - 5 years for batteries. A solar home system is a big investment for the customer and therefore should last longer than 2 years. In addition to the consumer's investment, product longevity is important for the environment and to maintain the image of solar.

-Lead acid batteries do not typically have more than a 1-year supplier warranty, due to perceived risk of misuse. Production mistakes are of course taken into account, but the market has shown to be resilient towards making a distinction between production faults and just common overuse limiting battery productivity.

- Contrary to one-light lanterns, the market for solar home systems has faced its share of market spoilage by systems not operating beyond 3 years. If Lighting Global is promoting systems that are only expected to last 2 years, this can create a very bad name for the high quality solar home systems that have expected lifetimes of 20 years (with 5 year battery replacements).

Comments from other respondents:

-Lighting Global should not dictate a minimum warranty time period for "systems" as this crosses over into the territory of defining business models, which we feel is not Lighting Global's role. We also feel that solar home "systems" include too wide a diversity of different components that it is difficult to blanket them under a simple blanket warranty standard (e.g. radios, TVs, phones, etc).

-Would be nice to have one minimum warranty term of 3 years for the system and the components.

RESPONSE: Thank you for your diverse feedback on the proposed warranty. Given that we received feedback suggesting that we should both increase and decrease our warranty requirements, we have decided not to change our proposed durations of 3 years for the system and 2 years for the battery. We anticipate further discussion on this topic and may revise this requirement in the future.

7.2 User manual

One respondent noted that in cases where a "plug-and-play" system is installed by the dealer, the unit should not necessarily require a user manual. They also imagine that they could potentially include all

necessary product information on the packaging rather than in a user manual. Given these scenarios, they don't feel a user manual should be included in the Quality Standard.

RESPONSE: We do feel it is important to include instructions for installation, use and troubleshooting of the system, even in cases where the system is installed by a trained technician. Safety guidelines are also critical to include. This information could potentially be included on the packaging rather than as a separate document, but would need to be accessible to the consumer. That said, we are still determining in practice how we can realistically evaluate user manuals given that, in many cases, to be relevant the instructions must be presented clearly in multiple languages to buyers with varying literacy levels.

7.3 Display of user interface / battery indicators

One respondent noted that in Ugandan standards for solar home systems, customer information displays, such as battery indicator lights, must be visible at eye-level height. Many kits would only comply with this requirement if the battery box were placed on a table or chair. They suggest that customers should be informed of the need to provide a "pedestal" to be able to easily see the battery indicator lights and/or that the battery protection be better than "normal" to account for the likelihood that customers will not be able to easily see the state of the battery.

RESPONSE: We agree that proper use and care of solar home systems is reliant on users being able to easily see and understand the state of charge of the system. We also agree that appropriate battery protection must be included in all solar home system kits. We are considering including an assessment of user interfaces, which may include an assessment of whether the interface is easily visible. This assessment will not be included in the initial round of testing, but may be included in the final quality assurance framework. We do not, however, feel that additional battery protection is warranted beyond that already required by the proposed standards.

7.4 After-sales Service

One respondent noted that the market for Solar Home Systems comes with a higher demand for after sales services as they are not an over-the-shelf product.

RESPONSE: We agree the higher cost and complexity of solar home systems demands a greater focus on after-sales service. As a global program, we are limited in our ability to monitor and enforce good after-sales service practices beyond ensuring that manufacturers are offering a consumer-facing warranty. We do not think it is appropriate to include additional metrics related to after-sales service in the Quality Standards, but do plan to continue to include program activities to help manufacturers improve their after-sales service practices.

8 Comments on future research plans

We also received several comments on our list of future research plans. Though some astutely noted that it is difficult to comment on things like Li-ion safety tests, IEC standards, LM80, and pay-as-you-go systems without knowing the details, others provided some initial feedback.

8.1 Wh/day metric

One respondent stated that a kWh per day metric is a simple way to compare systems as the focus moves from lighting to generating power for other activities. They noted that Lighting Global would need to provide a simple universal test method for manufacturers to measure this and account for all inefficiencies.

RESPONSE: We agree and are working on developing a method that can be standardized across all systems to determine the number of watt-hours (Wh) or kWh that would be available after a single day of solar charging.

8.2 Charge controller temperature compensation

Two respondents questioned the need for temperature compensation in charge control. One stated that they had concluded that it is not cost effective or required in small solar home systems and another suggested that a charging temperature cut-off would be sufficient.

RESPONSE: No decision has been made about whether or not to require temperature compensation. We do plan to conduct some research to better understand whether we feel it is necessary to require and determine how it could be objectively assessed. We appreciate any feedback that others can provide from their own research or other reputable sources.

8.3 Standards for larger modules

One respondent asked how we would define "larger" modules when considering requiring additional quality and durability standards.

RESPONSE: We would likely define larger modules in terms of their peak power rating. We have not yet determined what an appropriate threshold would be to require modules to be subject to additional tests nor determined what additional tests should be required. For the initial round of testing, all modules will be treated equally and will be required to meet the same standards that are currently used for pico-PV products. We will plan to research this issue further, and we will work closely with contacts from Technical Committee 82 (photovoltaics) of the International Electrotechnical Commission (IEC) as we assess options.

8.4 PAYG systems

Two respondents asked for more details on how we plan to assess pay-as-you-go (PAYG) systems. One stated that we might check the accuracy of the billing if per Wh, but this would not fit all models as some also include pay per time or a simple remote disable.

RESPONSE: We are still in the early stages of considering metrics and methods for assessing PAYG systems. We are planning to measure the standby loss of these systems and evaluate whether products still function as advertised when their PAYG software is enabled. In the coming months, we plan to engage with manufacturers and distributors of PAYG systems and other relevant stakeholders as we work to determine what other metrics should be assessed and to develop appropriate test methods for this assessment.

8.5 Performance Reporting Requirements

One respondent suggested that an easily understandable formatted performance report on the package would help distributors and end users to communicate, compare and make purchase decisions.

RESPONSE: An outcome of the stakeholder review last November was a clear need for performance metrics to be consistently reported on products. We are in the process of coordinating with GOGLA to determine appropriate requirements for performance reporting for pico-solar products. We anticipate that a similar framework will be developed for SHS kits.

Solar Home System Kit Minimum Quality Standards

Draft 2 September 2014

Lighting Global is in the process of expanding the quality test methods to cover larger solar home system kits. As an initial step, we have drafted a set of Minimum Quality Standards specific to these larger systems. Just as for the products already supported by the Lighting Global program, these Minimum Quality Standards for Solar Home System Kits will set a baseline level of quality, durability, and truth in advertising to protect consumers. Eligibility criteria for kits to be covered by these Standards are listed below, and the proposed Standards are presented in Table 1 on the next page.

On-going developments related to the development of the QA framework for solar home system kits will be posted on the Lighting Global Stakeholder page (www.lightingglobal.org/activities/qa/stakeholder-engagement/).

Product Eligibility Criteria

1. **All components required to provide basic energy services are packaged as a kit:**
   - PV module(s)
   - Charge control unit(s)
   - Battery/batteries
   - Cables, switches, and connectors sufficient to connect the PV module(s), charge control unit(s) and battery/batteries
   - Loads (optional)
     - Lighting and requisite cables
     - Load adapter cables (e.g., for mobile phones)
     - Other appliances (TV, fan, radio, etc.) and their requisite cables

   Note that the kit may consist of interchangeable components from a product family. The product family may be eligible for testing according to the Lighting Global Framework for Testing Product Component Families.
2. **The system voltage must be considered extra-low voltage (below 50 V DC).**
3. **Only DC systems, outputs and loads are covered.** No inverters or AC outputs/outlets, or AC appliances are eligible for support through Lighting Global.
4. **The peak power rating of the kit is less than or equal to 100 Watts.**
5. **Kits must be plug-and-play.** Plug-and-play implies that no design expertise is required to choose appropriate system components and no technicians or electricians are necessary to safely and successfully install and operate the system. All electrical connections can be made without the use of tools. Installation and operation instructions should be presented using language and graphics that can be understood by the typical consumer.

Table 1. Solar Home System Kit Minimum Quality Standards

Category[a]	Metric	Quality Standard	
Truth In Advertising	Manufacturer	Accurately specified	
	Product Name & Model #	Accurately specified	
	Performance Claims: Light Output, Run Time, Appliance Power Consumption	If reported, accurately specified[b]	
	Lamp Type, PV Power, Battery Capacity, Charger Rating, Other Aspects	If reported, accurately specified[b]	
	Functionality	All advertised features must be functional. Any description of the product that appears on the packaging, inside the package and in any other medium (internet, etc.) should be truthful and accurate. No statements should mislead buyers or end users about the features or utility of the product.	
Lumen Maintenance	Lumen Maintenance at 2,000 Hours	≥ 90% of specified light output at 2,000 hours OR ≥ 95% of specified light output at 1,000 hours (tested at highest setting)	
Health and Safety	Circuit and Overload Protection	The system must pass an overcurrent protection test and an overload protection test. Products must include a current limiting mechanism to prevent irreversible damage to the system. The mechanism must be easily resettable or replaceable by the user, or must automatically reset. If replaceable fuses are used for circuit protection, sizes must be labeled on the device and listed in the user manual, and, if fuses are replaceable by the user, at least one spare fuse must be included with the product.	
	AC-DC Charger Safety	Any *included* AC-DC charger carries approval from a recognized consumer electronics safety regulator[c]	
	Wiring and Connector Safety	Wires, cables and connectors must be appropriately sized for the expected current and voltage	
	Hazardous Substances Ban	No battery may contain cadmium or mercury at levels greater than trace amounts (<0.0005% Hg and <0.002% Cd by weight in accordance with the EU Battery Directive)	
Battery	Replaceability	Batteries must be field replaceable	
	Battery Protection	Protected by an appropriate charge controller that prolongs battery life and protects the safety of the user[d]	
	Battery Durability	All samples must pass the battery durability storage test[e]	
Quality and Durability	PV Overvoltage Protection	If the battery is disconnected, the system must not be damaged and PV open-circuit voltage must not be present on load terminals	
	Reverse Polarity Protection	The user interface should be designed to minimize the likelihood of making improper connections. If improper or reversed connections can easily be made, they should cause no damage.	
	Physical Ingress Protection (for components containing electronics or electrical connections)	Fixed Outdoor Components	IP5x
		All PV Modules	IP4x
		All Other Components	IP2x

Category[a]	Metric	Quality Standard	
Quality and Durability continued	**Water Protection[f] (for components containing electronics or electrical connections)**	Fixed Outdoor Components	Permanent outdoor exposure: IPx5 OR IPx3 AND circuit protection
		All PV Modules	Outdoor rooftop installation: Modified IPx4 OR circuit protection
		Portable Integrated Components	Frequent rain: IPx3 OR technical equivalent OR IPx1/equivalent + warning label
		Portable Separate Components	Occasional rain: IPx1 OR technical equivalent OR with warning label
		Fixed Indoor Components	No requirement
	Drop Test	Portable components	All samples are functional after drop test (1 m onto concrete); none result in dangerous failures[g]
		Fixed Indoor and Outdoor Components	No requirement
	Soldering and Electronics Quality	System and any included appliances must pass a soldering, electronics and assembly inspection	
	Switch, Gooseneck, Moving Part, and Connector Durability	Mechanisms expected to be used regularly	System is functional after 1000 cycles
		Mechanisms expected to be used primarily during installation	System is functional after 100 cycles
	Strain Relief	All cables must pass a strain relief test	
	Cable Specifications	Cables must be at least **5 m** long when connecting a "fixed indoor" or "portable separate" component to the PV module or any other fixed outdoor component.. Otherwise, components will be considered "fixed outdoor" or "portable integrated." Any outdoor cables must be outdoor-rated and UV resistant.	
Consumer Information	User Manual	User manual must present instructions for installation, use and troubleshooting of the system. Installation instructions must include appropriate placement and installation of the PV module. Basic electrical safety and system maintenance must also be covered. Installation and operation instructions should be presented using language and graphics that can be understood by the typical consumer.	
	Minimum Warranty Terms	Accurately specified and consumer-facing; minimum coverage of at least three years for the system and PV module and at least two years for the battery. Details are noted below.	

Note: Additional Standards are under consideration to be included in the final framework targeted for release in June 2015. Details of the assessment methods and implementation of these Standards will be researched and discussed over the next year. Topics under review are listed below. Note that this is not an exhaustive list, nor is it guaranteed that all topics will be included in the final framework.

- Extending the eligibility criteria to allow products with peak power ratings greater than 100 W and/or products that use screw terminals.

- On-the-box performance reporting requirements such as daily energy service in units of watt-hour per solar day (Wh/day)
- Temperature compensation in charge control
- Charge control safety standards and assessment of additional functions, such as equalization
- Requiring Li-ion batteries to be certified to have passed specific safety tests
- Additional quality and durability standards for larger PV modules. Methods may be drawn from IEC 61215, but lower cost methods may be devised.
- Additional safety standards for any appliances included with the kits
- Assessment of user interfaces to ensure that any indicators providing information about the state of charge are functional and accurate
- Thorough assessment of appliance outlets, USB and charging ports
- Acceptance of LM80 data for meeting the lumen maintenance Standard
- Assessment of pay-as-you-go (PAYG) systems

Warranty Requirements Details

To meet the Standard, Lighting Global requires that the following guidelines be followed when presenting and offering a warranty:

- The minimum warranty period is three years for the system and PV module and two years for the battery from the time of purchase by the end-user.
- The warranty must cover, at a minimum, manufacturing defects that impede operation under normal use and protection from early component failure.
- The consumer-facing warranty must explain how the consumer can access the warranty (return to point of purchase/distributor/service center, call or SMS a number, etc.), how the warranty will be executed (repair, replacement, etc.) and should advise the customer to inquire about the warranty terms prior to purchase.
- Full terms of the warranty must be available to the consumer in writing in a way that enables the end user to verify and understand the terms of the warranty prior to purchase. The written information should be in a regionally appropriate language. Consumer-facing warranties could be included on the product box or on a warranty card that is easily accessed prior to purchase.

Note that this is a *Minimum* Standard and it is up to the discretion of manufacturers and distribution partners to exceed the basic protection offered in these terms to differentiate the best quality products in the market.

Other Notes

[a] If a sample fails on any aspect at any point during testing, even if not during the specific test used to evaluate that aspect, the sample will still fail on the basis of that aspect. For example, if a switch stops functioning on a sample while its luminous flux is being measured, this failure would be included in the count of failures for the switch test.

[b] Numeric aspects, such as light output and run time, must deviate no more than 15% from advertised ratings (though it is always acceptable if actual performance is better than advertised).

[c] Approved marks: UL or similar

[d] Table 2 contains recommended battery deep discharge protection voltages during testing and Table 3 contains recommended battery overcharge protection voltages and maximum cell temperatures specific to the five common types (i.e., chemistries) of batteries. These default values are used when determining appropriate charge controller behavior, unless alternate appropriate design values are provided by the battery manufacturer for the deep discharge protection voltage cutoff, overcharge protection voltage cutoff or maximum cell temperature. Note that the minimum voltage specification for nickel-based batteries only applies in cases where more than one cell is wired in series.

Table 2. Recommended battery deep discharge protection voltage specifications

Battery type	Recommended deep discharge protection voltage (V/cell)	Minimum allowable discharge protection voltage (V/cell)	Maximum allowable discharge protection voltage (V/cell)
Flooded lead-acid	≥ 1.87	1.82	--
Sealed lead-acid	≥ 1.87	1.82	--
Lithium-ion	≥ 3.00	2.95	--
Lithium iron phosphate	≥ 2.50	2.45	--
Nickel-metal hydride	= 1.00	0.95	1.10

Table 3. Recommended battery overcharge protection voltage and temperature specifications

Battery type	Recommended overcharge protection voltage (V/cell)	Minimum allowable overcharge protection voltage	Maximum allowable overcharge protection voltage	Maximum charging temperature (°C)
Flooded lead-acid	≤ 2.40	2.35	2.50	TBD
Sealed lead-acid	= 2.40	2.35	2.45	45
Lithium-ion	≤ 4.20	--	4.25	45
Lithium iron phosphate	≤ 3.65	--	3.70	45
Nickel-metal hydride	≤ 1.45	--	1.50	60

[e] The battery durability storage test requirement may be waived for flooded lead acid batteries which are shipped dry. In cases where batteries are shipped dry, manufacturers must provide the test labs with an adequate amount of the appropriate solution or accurately specify the density and composition of the solution to be used.

[f] There are two alternative water protection compliance pathways allowed by Lighting Global (i.e., these are alternatives to meeting the IP class requirements). In one alternative ("technical equivalent"), the whole system of protection (ingress protection + electronic circuit protection + manufacturing QC) is evaluated to determine if the protection level is equivalent to that of a product with the required level of ingress protection. In another alternative ("warning label") there are clear messages to the consumer about the degree of protection from water. The warning level messages must meet Lighting Global program guidelines. The pathways and associated guidelines are described in greater detail in a document titled "Integrated Water Protection Assessment."

[g] Dangerous failures are defined as those which may expose the user to physical harm, such as harmful chemicals, heat (e.g., from an electrical short or fire), or sharp materials (e.g. broken glass).