

Revision of the Minimum Standards and Performance Targets for Lighting Global, Lighting Africa, and Lighting Asia

October 2013

This memo summarizes updates to the Lighting Global Minimum Quality Standards (“Standards”) and Recommended Performance Targets (“Targets”) that will be effective January 1, 2014. Details on the process that lead to this set of updates, including the originally proposed changes, program history, and motivation for these changes, is described in a stakeholder outreach memo released on June 7, 2013 that is available on the stakeholder page on the Lighting Global website:

<http://www.lightingglobal.org/activities/qa/stakeholder-engagement>

The final program decisions described in this memo were shaped by the insightful, critical and informative stakeholder feedback received between June 10 and August 23, 2013. Following the memo are two supporting documents: 1) a program policy document presenting the Minimum Quality Standards that will go into effect January 1, 2014 and 2) a list of synthesized stakeholder comments with public responses from the Lighting Global team.

Summary of Changes to Minimum Quality Standards:

Lighting Global received broad stakeholder support for the proposed changes to the Standards presented in June and will **adopt all of the proposed changes to the Minimum Quality Standards** (Table 1). The official version of the new Minimum Quality Standards is included with this memo at the end of the document. Further, the new Standards are harmonized across the regional lighting programs, meaning that meeting these Standards is a prerequisite for receiving services through Lighting Africa, Lighting Asia, and associated IFC and World Bank programs.

Table 1. Summary of proposed changes to the Minimum Quality Standards and stakeholder responses

Aspect	Proposed Change Summary	Stakeholder Response
Lumen Maintenance	Increase requirement from L70 @ 2000 hrs to L85 @ 2000 hrs.	Broad support to adopt (*with a few technical comments)
Battery Durability	Implement a battery storage test that simulates deep discharge in supply chain.	Broad support to adopt (*with a few technical comments)
Hazardous Materials (battery only)	Ban batteries with cadmium or mercury in alignment with the European Battery Directive.	Broad support to adopt (*with some suggestions to further adopt RoHS or REACH regulations)
Ingress Protection	Extend water ingress protection requirements to PV module junction box	Broad support to adopt (*with a few technical comments)
Warranty	Increase the warranty requirement from six months to one year.	Most stakeholders supported, though there were numerous and varied suggestions on implementation

In addition to increasing the duration of the warranty Standard, Lighting Global has chosen to further **clarify the terms of the warranty and the reporting requirements**. To meet the Standard, Lighting Global requires that the following guidelines be followed when presenting and offering a warranty:

- The minimum warranty period is one year from the time of purchase by the end-user.
- The warranty must cover the entire product, including the battery.
- 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 should 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.

We expect many manufacturers and/or distributors will choose to offer a more robust warranty to differentiate their products, and stress that this warranty requirement, like others, is a *Minimum* Standard.

Along with adoption of these changes to the Standards, spurred by questions and concerns raised in the stakeholder process, the Lighting Global team intends to **conduct the following activities to continue improving the Standards**:

- Investigate the potential to conduct lumen maintenance tests at an elevated temperature for accelerated testing.
- Research the cost and implications of RoHS and REACH compliance, including particular attention to the economic and technical feasibility of RoHS and REACH compliance for smaller, less established companies.
- Outline details of a test method for conducting the PV junction box water ingress test.
- Determine appropriate thresholds for a control circuit ‘standby loss’ Standard for potential future inclusion.
- Explore the potential to develop a method for assessing and reporting mobile phone charging and other auxiliary power capabilities; one option that has been suggested would involve a consumer-facing message to ensure end-users are aware of the tradeoff between mobile charging and lighting services.

Summary of Changes to Recommended Performance Targets:

Stakeholders expressed many concerns about the Performance Targets, many of which fell into two related critiques:

- **The role of the Performance Targets in the Lighting Africa/Asia/Global programs is not well understood** by many stakeholders and is often misconstrued as a minimum level of performance intended for broad application. The Targets were originally combined in a single policy with the Standards but were separated based on stakeholder feedback in 2011, one year

after the original policy was released in conjunction with the kick-off of the Quality Assurance Program. The Standards are meant for global application and encompass the most important aspects of products: quality, durability, truth-in-advertising, and consumer protection. Since the Targets were split from the Standards, their intended purpose has been for internal program use—making decisions about which product to include in certain consumer-outreach campaigns.

- **It is difficult to set appropriate Performance Targets for a wide range of products and contexts** because of people's range of unique individual lighting needs and diversity in income and expectations. Some stakeholders suggested setting a multi-level set of Performance Targets to accommodate various types and ranges of products. Others suggested eliminating the Performance Targets altogether.

In response to this feedback, and in line with the original intention of the Targets, Lighting Global will deemphasize the role and eliminate the public presence of the Targets. Lighting Global will stop all public advertisement with regard to whether products meet the Performance Targets. This will include removing the check marks next to products on the website and removing the mention of Performance Targets on Spec Sheets and other materials. The policy will go into effect as soon as possible, prior to January 1, 2014. Internally, performance thresholds will still be used to guide selected program decisions for Lighting Global, Lighting Africa, and Lighting Asia (see below for additional discussion).

New framework for Performance Reporting

As part of the transition away from Performance Targets in the market, **Lighting Global will implement a new policy on performance reporting requirements (as part of the Minimum Standards) that will be shaped by a stakeholder engagement process that will begin in November, 2013.** The anticipated date for announcing the new policy is May 1, 2014, and the anticipated date for the provisions to go into effect is August 1, 2014. A key priority for the Quality Assurance framework is ensuring buyers have the information they need to assess performance. The truth-in-advertising criteria in the Standards can protect consumers, but only if there are basic, comparable levels reported on packages.

Lighting Global plans to implement a new policy with regard to performance metrics that is consistent with the following guidelines:

1. All manufacturers are required to accurately present performance metrics (brightness/light output and daily runtime) on product packaging and other relevant consumer-facing materials to enable retail buyers and distributors to compare products and make educated choices.

[NOTE: The details on the requirements for this aspect will be the subject of the stakeholder engagement process.]

2. Products that offer and advertise mobile phone charging or other auxiliary services must add an informational element in the consumer-facing packaging (text or graphic) that describes the effect of mobile phone charging on product performance. This does not need to be quantitative,

but is intended to ensure that the consumer is aware of the tradeoff between using the available stored energy for lighting or other services.

3. Lighting Global/Africa/Asia maintain the authority to create and use internal minimum performance thresholds for activities like consumer-awareness campaigns and competitions. These thresholds will be referred to as “eligibility criteria for participation in consumer awareness campaigns” (or something similar) to better reflect their intended, targeted role in the program.
4. For a product to be eligible to participate in Lighting Africa or Lighting Asia supported consumer awareness campaigns, the product must meet both the light output and run time eligibility criteria on at least one light level.¹ These thresholds will go into effect on January 1, 2014. Products that complete testing before this date will be eligible for consumer awareness campaigns based on the existing thresholds until their test methods expire.
 - **Light Output** must be greater than 25 lumens or greater than 50 lux over an area of 0.1 m² under test conditions described in IEC TS 62257-9-5.
 - **Run time** must be greater than 4 hours per-day for solar-charged products or 8 hours full-battery run time for products that do not include an individual solar module and are meant for central charging. Other targets may apply in cases where products utilize other charging methods (e.g. dynamo charging).

[Note that the light output criterion reflects the updates proposed by Lighting Global in June 2013, while the run time criterion is similar to the existing Target. The new run time criterion has the same basic levels but also requires that any product packaged with a solar module must meet the solar run time criterion of 4 hours per day and cannot rely on full-battery run time to pass.]

Upcoming Stakeholder Engagement

The stakeholder engagement process to refine a framework for reporting performance to the market will be announced and launched in November 2013. The goal is to work relatively quickly to develop updates that can go into effect by August 1, 2014. The anticipated date for announcing the new requirements is May 1, 2014, which would provide manufacturers with a period of three months to comply with the new format.

A key issue is that a light output metric reported in terms of lumens may not be easily understood or interpreted by much of the market. With this concern in mind, Lighting Global plans to focus this engagement with stakeholders, explore evidence from other programs and markets, and leverage field studies to determine the best framework for reporting light output in this market. While a reporting system in lumens will be considered, alternative metrics for communicating light output and/or supporting awareness campaigns will also be considered. Possible alternatives and complementary activities might include reporting light output in candle-equivalents, reporting using a graphical display of brightness, or funding consumer awareness activities that include information about lumens or other metrics. The final approach may include a combination of those approaches or wholly new approaches.

¹ Average measurements must not be less than 10% of the criterion threshold and no single measurement may be less than 20% of the threshold.

Another important aspect for stakeholder input is ensuring the requirements align with buyer literacy and expectations about how information will be conveyed.

Finally, the stakeholder process will guide Lighting Global communication and education support to the market. Based on feedback we will develop new outreach materials to educate MFIs, distributors and consumers on how to interpret the new metrics and/or the specification sheets, as is appropriate for the audience.

Conclusion

Thanks to another effective stakeholder engagement with important contributions from a number of market participants, the final revisions to the Standards and the elimination of public Targets will better serve and inform the market. The decision to deemphasize the Performance Targets and instead require performance metrics to be reported on products is aligned with the philosophy of using “truth-in-advertising” as a central principle for ensuring quality assurance and transparency, which is appropriate for the maturing off-grid lighting market.

For reference, a summary policy document for the new Minimum Quality Standards is presented below as Appendix A. Following this document is the list of stakeholder comments with responses from the Lighting Global team in Appendix B.

Appendix A:

Lighting Global Minimum Quality Standards

Public Summary Document

Effective January 2014

Lighting Global maintains the Minimum Quality Standards, a set of off-grid lighting benchmarks that set a baseline level of quality, durability, and truth-in-advertising to protect consumers. The Quality Standards are summarized below and listed in more detail on the following page. The official policy document is titled “Lighting Global Minimum Quality Standards Policy -Version 2014.a” and will be available at www.lightingglobal.org/

Conformance with the Quality Standards is evaluated based on results from laboratory testing according to the Quality Test Method (QTM) in the latest edition of the International Electrotechnical Commission (IEC) Technical Specification 62257-9-5. The tests are conducted at a third-party, approved test center using randomly-procured samples. Information contained in Lighting Global Standardized Specifications Sheets (SSS) is acceptable for determining conformity with the Quality Standards; any product with an up-to-date SSS is required to have passed the Quality Standards.

Summary of Minimum Quality Standards



Truth-in-Advertising: Accurate consumer-facing labeling (e.g., rated run time, light output battery capacity, PV power).

Lumen Maintenance: L85 time is greater than 2,000 hours.

Battery: Must be durable and adequately protected.

Health and Safety: Batteries may not contain mercury or cadmium, products are safe.

Durability and Quality: Appropriate protection to prevent early failure.

Warranty: At least one year of coverage.

Effective August 1, 2014 or by program announcement:

Performance Information: Run time and brightness reported.

Category	Metric	Quality Standard	
<i>Truth In Advertising</i>	Manufacturer	Accurately specified	
	Product Name & Model #	Accurately specified	
	Light Output	If reported, accurately specified ^a	
	Lamp Type	If reported, accurately specified	
	Run Times	If reported, accurately specified ^a	
	Charger Rating	If reported, charger power rating accurately specified (e.g. PV power or mechanical charge time)	
	Other Aspects	If reported, accurately specified	
<i>Lumen Maintenance</i>	Lumen Maintenance at 2,000 hours	≥ 85% of specified light output at 2,000 hours OR ≥ 95% of specified light output at 1,000 hours (depreciated at highest setting)	
<i>Health and Safety</i>	AC-DC Charger Safety	Any <i>included</i> AC-DC charger carries approval from a recognized consumer electronics safety regulator ^b	
	Hazardous Substances Ban	No battery may contain cadmium or mercury at levels greater than trace amounts	
<i>Battery</i>	Battery Protection	Protected by an appropriate charge controller that prolongs battery life and protects the safety of the user	
	Battery Durability	5 of 6 samples must pass the battery storage durability test as defined in IEC 62257-9-5 Annex BB.	
<i>Quality and Durability</i>	Physical Ingress Protection	<i>Fixed Outdoor</i>	IP 5x
		<i>Others</i>	IP 2x
	Water Protection ^c	<i>Fixed Indoor</i>	No requirement
		<i>Portable Separate</i>	Occasional rain: <i>IP x1 OR technical equivalent OR with warning label</i>
		<i>Portable Integrated</i>	Frequent rain: <i>IP x3 OR technical equivalent OR IP x1 / equivalent + warning label</i>
		<i>Fixed Outdoor</i>	Permanent outdoor exposure: <i>IP x3 AND circuit protection</i>
		<i>All PV Modules</i>	Permanent outdoor exposure: <i>IP x3 AND circuit protection</i>
	Drop Test	<i>Fixed Indoor</i>	None result in dangerous failures ^d
		<i>Others</i>	5 out of 6 samples are functional after drop test (1 m onto concrete); None result in dangerous failures ^d
	Soldering and Electronics Quality	Pass soldering and electronics inspection (without endemic bad joints, pinched wires, etc.)	
Switch, Gooseneck, Connector, and Strain Relief Durability	5 out of 6 samples are functional after 1000 cycles (switch, connector, gooseneck tests); 5 out of 6 samples are functional (strain relief test); None result in dangerous failures (all tests)		
<i>Warranty</i>	Minimum Warranty Terms	Accurately specified and consumer-facing; Minimum coverage of at least one year on manufacturing defects under normal use, including the battery. Details are noted below.	

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 one year from the time of purchase by the end-user.
- The warranty must cover the entire product, including the battery.
- 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 Effective August 1, 2014 (or by program announcement), all manufacturers will be required to present performance metrics (brightness/light output and runtime) on product packaging and other relevant consumer-facing materials to enable consumers and distributors to compare products and make educated choices. Lighting Global will begin a stakeholder engagement process in November 2013 to refine a framework for reporting performance to the market.

^b Approved marks: UL or similar

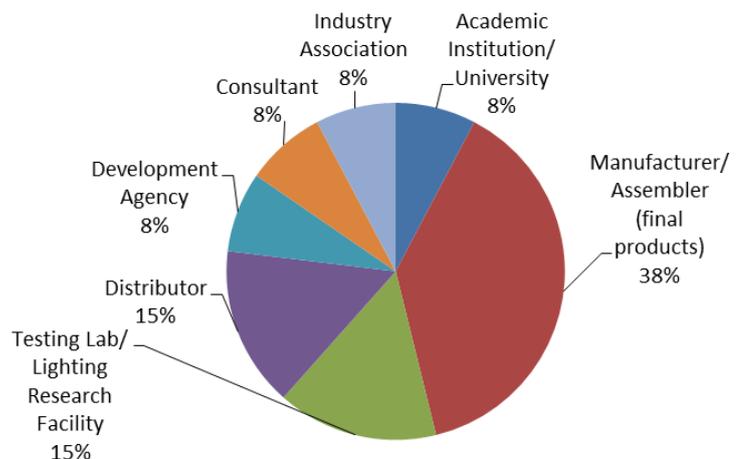
^c There are two alternative Water Protection compliance pathways allowed by Lighting Global (i.e. these are alternatives to meeting the IP class requirements). In one alternative (“technical equivalent”), the whole system of protection (ingress protection + electronic circuit protection + manufacturing 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.”

^d 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).

Appendix B: Responses to Standards and Targets Stakeholder Process August 2013

Thank you all for providing feedback on the proposed changes to the Lighting Global Minimum Quality Standards and Recommended Performance Targets.

We received numerous comments from 13 different stakeholder organizations with a wide variety of connections to off-grid lighting. Respondents included manufacturers, distributors, NGOs, development agencies, academic institutions and test labs.



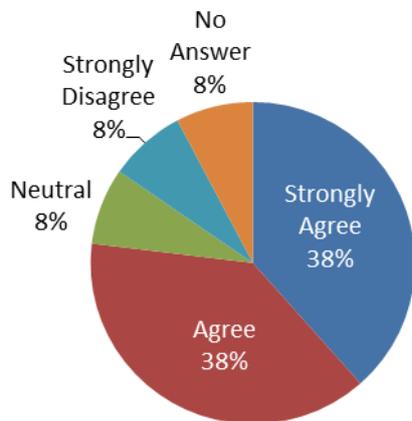
Feedback has been organized according to the questions asked in the stakeholder survey. A synthesis of comments on each question or sub-topic is presented, along with responses from the Lighting Global team. While some text was altered from the original submissions, alterations were not intended to change the meaning of the comment, but only to condense responses and protect the anonymity of the respondent. Similar comments from multiple stakeholders were combined. Comments that did not require a response are not included in this document, but were noted by the team.

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1. Do you agree with the proposed structure for Standards and Targets as outlined in Policy Change 1?



Lighting Global will maintain a harmonized set of Standards and each regional program—Lighting Africa and Lighting Asia-India—will reference those along with a harmonized set of eligibility criteria for participation in consumer awareness campaigns. Nearly all participants agreed with this decision.

While most respondents agreed that the Lighting Africa and Lighting Asia targets should be aligned, we received four main categories of comments that raised concerns about the proposal.

Comment 1a: Multi-level Targets

Throughout the stakeholder survey, several respondents suggested that an alternative structure could include several sets of Recommended Performance Targets based on the price category of the product. Some NGOs and institutions are interested to make purchase/financing decisions based on the Lighting Global Targets, but the current Targets are set too low to be meaningful for the more expensive products.

Response 1a.

Though this idea has merit, it is faced with the issues of adding complexity to the framework, creating artificial boundaries and providing mixed incentives. In our testing history, we have seen a clustering of products around the Performance Targets that have been set, which indicates that some manufacturers will design to just meet the Targets (in response to demand from buyers and regulators who use them as a shortcut for determining minimum performance). A multi-level target may have the unintended consequence of reducing the diversity of products in the market if manufacturers cluster around the price or performance boundaries.

We agree that the current Performance Targets are not relevant for more expensive or higher-performing products and this issue, among other concerns, has influenced our decision to deemphasize the role of the Performance Targets in the quality assurance program. Performance Targets will now be referred to as “eligibility criteria for participation in consumer awareness campaigns” (or something similar) and the website will no longer indicate whether a product meets the Targets.

By making Standardized Specification Sheets (<http://www.lightingglobal.org/specs/>) publicly available for each product, we enable and encourage entities to set their own internal targets for the performance requirements of a product. Further, within the next year, we plan to require that all products display basic performance metrics to enable consumers to effectively compare products based on their performance.

Comment 1b: Better Communication Needed

Throughout the stakeholder survey, several respondents noted that the distinction between the Standards and Targets was confusing or that the Targets were given too much emphasis. Some specific comments include that it is confusing to distinguish between Standards and Targets and many organizations and distribution partners feel that if a product does not meet Performance Targets, it is not a quality product and doesn't “meet” Lighting Global standards (which is not true).

Respondents mentioned that even the Navigant proposal for an “Off-Grid Lighting Certification Body” recommends for the Performance Targets as well as the Minimum Quality Standards to be taken up by a

third party certification body. Respondents felt that despite this external pressure, conforming all products, particularly ultra-low cost products, to meet the Performance Targets would have a negative impact and reduce innovation.

Response 1b.

It is helpful to have feedback about the confusion on Standards vs. Targets. As mentioned above, this feedback has influenced our decision to deemphasize the role of the Performance Targets in the quality assurance program. Performance Targets will now be referred to as “eligibility criteria for participation in consumer awareness campaigns” (or something similar) and the website will no longer indicate whether a product meets the Targets.

Comment 1c. Doubts about Global Targets Harmonization

A few respondents also felt that using harmonized Standards and Targets is acceptable so long as they are appropriate for both markets. Different levels of poverty and starting points on the energy ladder could result in the need for different expectations of performance. The respondents feel the study conducted by Lighting Global was not sufficient to set a universal benchmark across all customers, geographies and price-points on minimum hours and brightness and that these features should be left up to the market and the customer to decide based on multiple available product offerings.

Response 1c.

We based our original proposal to harmonize the Targets on field research in both Africa (Kenya, Tanzania, Ghana, Zambia and Ethiopia) and India. We had approximately 400 focus group participants across five countries in Sub-Saharan Africa and two Indian states. We obtained reasonably extensive coverage through this process for the regions supported by the Lighting Africa and Lighting Asia programs and were confident that the results provided sound input for our proposed Performance Targets updates. The comparison of these results and details of how we decided to recommend harmonizing the Targets are outlined in the memo on the stakeholder page: <http://www.lightingglobal.org/activities/qa/stakeholder-engagement>.

Of course, we welcome stakeholders who wish to share their own market research (and thank those that already have) that contradict or support the Lighting Global market research and will hold those results in confidence. As noted previously, we plan to deemphasize the role of the targets in the Lighting Global QA program.

Comment 1d. Eliminate the Performance Targets

Several parties suggested eliminating the Performance Targets altogether, with several rationales in addition to those alluded to in comments above:

As the Performance Targets are purely for Lighting Global’s own internal purposes for assessing which products to provide Lighting Africa/Lighting Asia marketing support to, they should be eliminated from the framework.

Eliminating the Performance Targets and keeping only the Minimum Quality Standards would simplify the Quality Assurance program and eliminate confusion in the market about the difference between Standards and Targets.

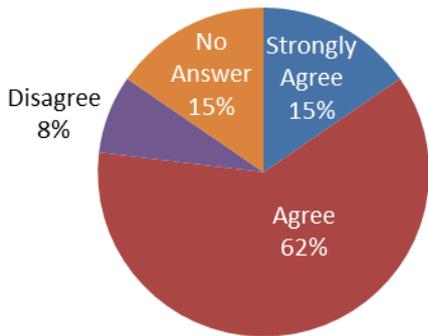
This elimination of Performance Targets would further ease the transition as Lighting Global expands their scope to include solar home systems and other more complicated systems in their testing programs.

We support all activities related to a “Truth in Advertising” concept in combination with powerful market surveillance. Performance targets in general should not be standardized since they have to be tailored to individual markets, applications and performance levels.

Response 1d.

We are working to reframe the communication around Standards and Targets (as described above) to place greater and appropriate emphasis on the Standards, which already include a strong truth-in-advertising component. Additionally, we will now require that all products report consumer-facing performance metrics. As mentioned above, we have decided to deemphasize the role of the Performance Targets in the quality assurance program. Performance Targets will now be referred to as “eligibility criteria for participation in consumer awareness campaigns” (or something similar) and the website will no longer indicate whether a product meets the Targets. Though we feel that deemphasizing the role of the Targets is appropriate, we do not plan to completely eliminate the performance eligibility criteria for Lighting Africa and Lighting Asia supported consumer awareness campaigns at this time.

2. Do you agree with the proposed change to the Lumen Maintenance threshold?



Nearly all respondents agreed that the lumen maintenance test should have a stricter passing threshold. The proposed change is to require that a product maintain at least 85% of initial light output after 2000 hours for "pass" or at least 95% after 1000 hours for an "expedited pass". Previously, a product had to maintain at least 70% of initial light output at 2000 hours.

All were in favor of raising the passing threshold for the lumen maintenance test, though two concerns were raised regarding the testing process.

Comment 2a. Run Lumen Maintenance at Higher Temperature

The lumen maintenance test is currently run at 25°C for 2000 hours, while in many locations in India and Asia, the nighttime ambient temperatures may be well over 25°C. (A review of historical recorded temperatures show that temperatures in May in New Delhi, India range between 30–35°C at night and between 25–35°C in Karachi, Pakistan.) Testing at 25°C may not be very representative of fixtures in the application environments, and a test running at 25°C for 2000 hours is not likely to show degradation in a predictive way. The test should be run at a higher temperature, in order to get more predictive results.

Response 2a.

This is a valid point and the lumen maintenance test results may under-predict degradation in environments with high nighttime ambient temperatures. The lumen maintenance test is specified in a way that makes it low-cost by running at essentially ambient “room” temperature in typical laboratory settings. A modification to the test for high temperature testing would involve some additional expense. We are not aware of issues in the field related to accelerated degradation for products operated in high temperature environments, and would be interested in evidence of this (even anecdotal), which could lead to more intense scrutiny of the temperature for testing.

The deviation of 30°C from 25°C also may not be as great as these comments imply, however. In absolute temperature terms, this can also be described as a difference between 498K and 505K. [Testing by CREE](#) shows that the difference in degradation between 25°C and 30°C is about 2-3%.

Based on this data and uncertainty, we do not plan to implement temperature-related changes to the lumen maintenance test at this time, but we are interested to explore this subject for the future.

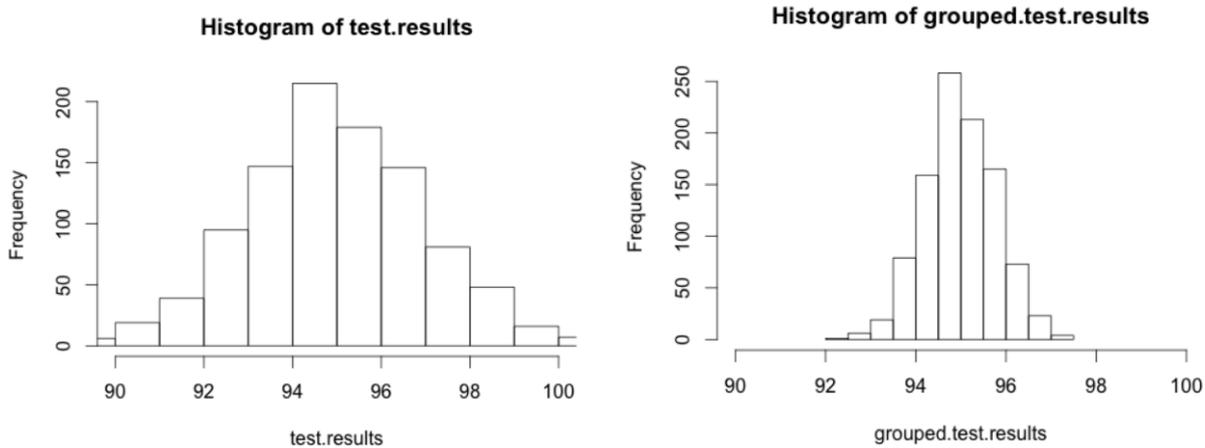
Comment 2b. Measurement Uncertainty in Lumen Maintenance

The measurement uncertainty associated with standard luminous flux measurement devices make it challenging to accurately assess a 95% threshold. This requires additional time and diligence throughout the measurement process which could increase testing costs.

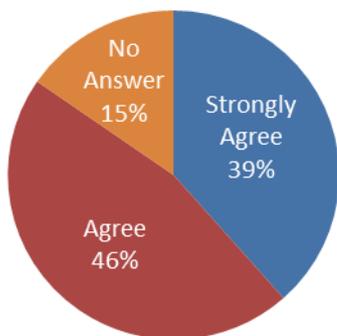
Response 2b.

This is a good point. In our experience, as long as the same light meter is used for subsequent relative measurements of light output, the precision of the test is sufficient to determine the relative light output to approximately 2%.

Since there are 6 samples under test and the basis for passing is the average measurement there is some additional precision from the grouped uncertainty (if the bias is not systematic there will be deviations in both directions and the expected average measurement for the six samples will be closer than 2% to the true average). This is shown in the pair of histograms below. The first shows “test results” for an individual product assuming that the true value is 95%, but there is some deviation due to measurement error with a normal distribution and a standard deviation of 2%. The second shows how the average result for random groups of six products measured in this way are distributed. There is a much tighter tolerance around the true value.



3. Do you agree with the proposed Battery Durability criteria?



All respondents agreed with adding the new battery storage durability test and battery durability criteria.

Though all respondents were in agreement on including the battery durability criteria, some expressed concern about the possibility of creating an uneven market by enforcing new or higher standards on entering products than those that have already been tested and will maintain verification letters for two years. This concern will be addressed later along with general comments. One respondent provided a best practice recommendation for the test method.

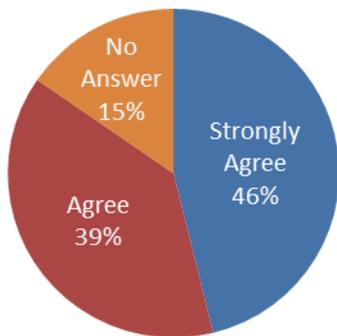
Comment 3a. Should Use Battery Cycling Test

Battery quality and durability is critical for BOP customers. As considered best practice in the mobile phone industry, batteries should be cycled at least 1000 times.

Response 3a.

While battery cycling tests are valuable, they are typically expensive and equipment intensive to conduct. Core goals of the Lighting Global quality assurance program are to keep testing costs low and expedite testing so that tested products can be released into the market in a reasonable time period. The proposed battery durability test better meets these goals. Additionally, one of the most common complaints reported from the field with regard to batteries is that some sealed lead acid (SLA) batteries either fail or do not function at their rated capacity directly after purchase due to deterioration that occurs while the batteries are in the supply chain. We feel that the battery durability test better replicates the conditions experienced by batteries while they sit, unused and uncharged, in the supply chain (frequently for many months).

4. Do you agree with the proposed Hazardous Substances Ban?



All respondents agreed on including a ban on mercury and cadmium batteries.

In addition to all respondents agreeing with the decision to ban the use of batteries containing cadmium or mercury, several respondents stated that they already use this criterion in their purchasing or financing decisions and would welcome it being added to the Lighting Global Minimum Quality Standards. Another respondent elaborated that this ban was a good idea, despite the fact that most BOP customers would not be aware or care

about the use of these batteries. One respondent suggested that the ban was not strict enough and another suggested that rather than creating a stand-alone ban, Lighting Global should rely on existing standards; these comments are presented below.

Comment 4a. Strengthen Hazardous Substances Ban: Include RoHS and Ban Lead

The proposed Hazardous Substances Ban should be strengthened: manufacturers should also be asked to self-declare compliance with RoHS guidelines and lead-acid batteries should be banned. Lead is a hazardous substance, and despite the fact that the recycling rate of lead-acid batteries is likely higher than that of NiCd batteries in developing countries, these batteries should not be permitted. As many manufacturers are replacing lead acid batteries with lithium batteries, banning lead-acid batteries should not adversely impact companies.

Response 4a.

These are issues that have been considered and the subject of both internal discussions and discussions with outside stakeholders. We agree that RoHS compliance would be ideal; however, we feel it could represent a costly burden for some manufacturers at this point. We did not originally include RoHS compliance in the Standards update because we did not want to further increase the cost of compliance for manufacturers. We note that RoHS compliance is generally based on self-declarations by manufacturers. The declarations must be supported by documentation. We have some concern that the cost of providing the necessary documentation could be high for some companies. This may be especially true for small companies that work with multiple suppliers.

The issue of lead-acid batteries is a separate concern as batteries are not currently included in RoHS regulations. As lead-acid batteries are both more-commonly recycled and available than many other battery types, we did not feel it was appropriate to ban them at this time. Our hope is that poor-performing lead-

acid batteries will be detected by the battery durability test, thus reducing the hazardous waste resulting from these batteries.

Comment 4b. Adopt RoHS and REACH

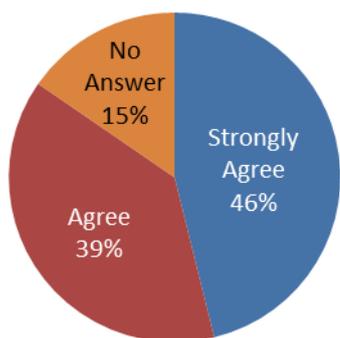
Banning technologies which are still state of the art in the market (e.g. CFL) should be avoided. RoHS standards should be adopted immediately, which are generally accepted in consumer electronics markets. At a later point the program should also aim for adopting REACH standards. Lighting Global and the industry should not adopt stand-alone regulations if it can make use of existing standards, recommendations and/or regulations.

Response 4b.

There is no proposal to ban CFL. The restriction on hazardous materials in batteries we are adopting does not apply to light sources. Further, as mentioned above, RoHS does not address batteries and we felt that these were of particular concern in the off-grid lighting industry.

We agree it is ideal to adopt harmonized regulations where appropriate and have done so for batteries: the EU Batteries Directive will be used to guide implementation. Further investigation on the cost and logistics for RoHS and REACH, among other certifications, is warranted.

5. Do you agree with the proposed changes to the Ingress Protection for External PV Modules criteria?



All respondents agreed that the revisions should close a loophole in the current ingress protection (IP) standard by requiring that external PV module junction boxes and electrical connections be resistant to permanent outdoor exposure.

While all respondents agreed that external module PV junction boxes should be resistant to permanent outdoor exposure, one respondent commented specifically on how this test might be conducted, and another asked for an additional standard for external PV modules.

Comment 5a. Test Method Suggestion for IP-testing of PV Modules

This change to the Standards will require additional testing which may modestly increase testing costs. To minimize this cost increase, a time-efficient test method must be developed. One suggestion is to submerge the sample panels in a bucket of water for an allotted time and then check each junction box to see if water had penetrated. This may be complicated by the fact that most junction boxes are sealed and difficult to open, which could result in a destructive or time-consuming task. A possible alternative would be to test electrical resistance following submersion; however, this method would need to be tested to verify accuracy.

Response 5a.

While it is true that this change involves a limited amount of additional ingress protection testing, we do not expect this to increase the overall testing cost substantially. We appreciate your suggestion on the details of how this test could be conducted in practice and we are working to finalize a time-efficient method for conducting this test.

Comment 5b. PV Modules Should Enable Direct Mobile Phone Charging

All PV modules should be required to enable direct charging of mobile phones. This feature would allow the battery to only be used for lighting and would prolong the battery life.

Response 5b.

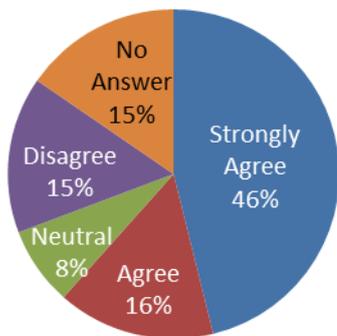
There are a variety of approaches to routing power in products, and Lighting Global’s position is that in nearly all cases, product design features like this are best left to the people who design (and sell) them.

While there can be a benefit to a product’s PV module having the capability to charge mobile phones directly, there are two key issues associated with making this a Standard:

- 1) Not all mobile phones are equal in terms of their internal circuitry and charging mechanisms, meaning that a PV module may be able to charge one type of mobile phone but not another; and
- 2) Most mobile phones charge from a 5V nominal USB socket, meaning the PV module would need to have a specific nominal voltage or an internal converter (which limits innovation and may add cost).

It should be noted that it can also be inconvenient for many people to charge during the day, and there are legitimate reasons people may prefer to charge at night (which requires solar energy to be temporarily stored in the product battery).

6. Do you agree with the proposed changes to the Warranty requirement?



Most respondents were in agreement that the warranty requirement be increased from 6 months to one year for the entire product, including batteries.

Though nearly all respondents were supportive of increasing the warranty requirement, several respondents felt that the warranty period should be longer, while others raised the issues related to the definition of the warranty period, terms and conditions.

Comment 6a. Two-Year Warranty

The warranty requirement should be increased to two years. This is a common standard used in other parts of the world and with the availability of higher-quality components, this commitment should not be difficult for manufacturers to meet.

Additionally, introducing a requirement for a no-questions-asked two-year (or longer) warranty will increase the confidence in the market. Similar strategies have been used successfully in the lighting industry in the past when historic data of long term performance had not been available for technologies newly introduced to the market (e.g., induction lighting, LED replacement lamps). This is particularly useful when technologies are expected to last for a long time and the test methodologies are not advanced enough to make accurate reliability predictions. From the end-user point of view, a no-questions-asked warranty reduces the uncertainty when buying a product that represents an investment of several days, if not months, worth of income. This requirement will in turn motivate manufacturers to produce better quality products and to test them in house more rigorously before shipment.

Response 6a.

We consider the one-year warranty requirement as an appropriate incremental increase to balance both the needs of the consumer with the abilities of manufacturers and distributors to effectively provide these services. Though a two-year (or longer) warranty may create greater confidence in the market, we do not feel that it is appropriate to require this as a Minimum Standard at this time. We also see this as an opportunity for individual companies or distributors to distinguish themselves from competitors by offering and honoring longer warranties.

We feel similarly about offering a “no-questions-asked” warranty. Currently the warranty requirement specifically covers manufacturing defects and early component failures. This language seems appropriate as a Minimum Standard, while we would encourage companies to again offer and honor more inclusive warranties both to simplify the warranty process and provide their customers with more confidence in their purchase.

We have heard anecdotally from distributors, retailers and customers that after providing “no-questions-asked” after-sales service, the resulting positive word-of-mouth advertising served as one of their most effective marketing campaigns.

Comment 6b. Agreement “This is important Improvement”

This is an important improvement. Customers must have confidence in the products so that they can spread the word about the benefits of solar lighting and of good quality products. Six months is not sufficient.

Response 6b.

We agree.

Comment 6c. Warranty Must Be Clearly Defined

The standard must be more clearly defined or it does not provide much value. For example, a 5 year warranty from a weak start-up manufacturer with no balance sheet is worthless as compared to a 1 year warranty from a publicly listed industrial giant. To resolve this, Lighting Global should either eliminate the warranty requirement from the minimum standard or propose a basic set of warranty requirements – i.e. a Lighting Global Standard Warranty – which includes service provision.

Additionally, it is important to define when the warranty period starts. Some components (especially the batteries) start the degradation immediately while the PV module, if well stored, should maintain its original performance.

Response 6c.

We agree that this standard required further definition. As part of the standards, we have provided guidelines for what must be included in the warranty language and specified that all warranty terms be consumer-facing and easily accessible prior to purchase.

The warranty language purposely does not specify how the warranty must be addressed, whether by refund, replacement or repair because these factors are strongly dependent on the product type and/or distribution model. A vertically integrated supply chain can be much different from diffuse “traditional retail” supply chains in places where off-grid lighting is sold. Manufacturers may have little influence on the actions of retail vendors in practice with respect to warranty service.

Though, given these reasons, the warranty standard does not specify how the warranty must be addressed, it does require that consumer-facing language explain how the consumer can access the warranty (return to point of purchase/distributor/service center, call or SMS a number, etc.) and how the warranty will be executed (repair, replacement, etc.). The warranty should further advise the customer to inquire about the warranty terms prior to purchase. These warranty terms 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. Consumer-facing warranties can be included on a warranty card that is easily accessed prior to purchase, allowing manufacturers to easily change the specifics of the warranty based on each market or distribution plan.

Also, monitoring for retail warranty fulfillment across the broad markets supported by Lighting Global is simply financially infeasible at this point. Though we realize that not all warranties are honored, and not all warranties are treated equally, we feel that requiring a consumer-facing warranty greatly increases the odds that a warranty will be offered and honored. Additionally, this requirement provides Lighting Global with leverage should repeated field reports indicate that a company is willfully not honoring their warranty.

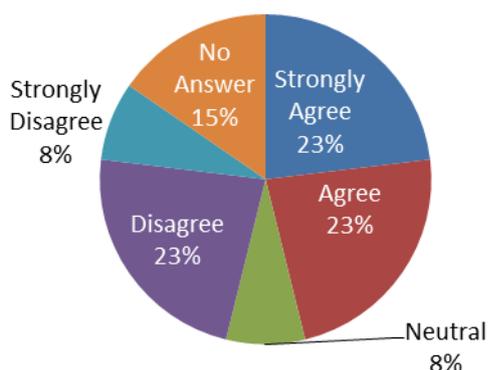
Comment 6d. Guarantee versus Warranty

Guarantee more than warranty is needed. Simple replacement guarantee of at least 1 year should be considered.

Response 6d.

Though some sources indicate a difference between warranty and guarantee, these words are commonly interchanged and no consistent distinctions exist; in this case we assume you are distinguishing the two based on whether a product is replaced (guarantee) or repaired (warranty). The warranty required by Lighting Global allows for repair or replacement of the product. The warranty method is at the company's/distributor's discretion. For some products, particularly smaller, lower-cost products, a simple replacement is more efficient and cost-effective. For other larger products, which are more difficult to transport and may involve some degree of installation, a repair or service warranty is often a better choice. Methods will further depend on the distribution network, overhead of the company and accessibility of the customers.

7. Do you agree with the proposed changes to the Run Time Performance Target?



Respondents were not all in agreement regarding the changes to the run time performance target. The proposed target would increase the required hours of run time for all products and require that all solar products meet the solar run time target. The proposed change was: "Products must provide a run time of 5 hours per day for solar-charged products AND 10 hours for full-battery run time for products that do not include a solar module." Previously, products had to provide 4 hours of solar run time AND/OR 8 hours of full-battery run time.

Respondents provided a variety of opinions regarding the proposed changes to the Recommended Performance Targets. Some more general comments, such as concerns regarding whether Recommended Performance Targets should be included in the Lighting Global quality assurance framework or whether the Targets should be further differentiated, are included here, along with specific comments about changes to the values of the run time Target.

Comment 7a. Multi-level Performance Targets

As expressed earlier in the survey, several respondents felt that there should be different sets of Performance Targets. For simple, low-cost lamps, four hours is likely sufficient for many customers. Higher-cost products could be expected to perform at a higher level and provide longer run times.

Response 7a.

Lighting Global has decided to deemphasize the role of the Performance Targets in the quality assurance program. Performance Targets will now be referred to as "eligibility criteria for participation in consumer awareness campaigns" (or something similar) and the website will no longer indicate whether a product meets the Targets.

The regional programs (Lighting Africa and Lighting Asia) will maintain “eligibility criteria for participation in consumer awareness campaigns” which set a minimum run time and light output. Based on research and stakeholder feedback, this minimum solar run time will remain at 4 hours per day for solar-charged products and a full-battery run time of 8 hours for products that do not include a solar module.

Lighting Global does not plan to introduce multi-level targets. Bulk purchase buyers and other market actors should consult the best available information about their market and end-users to determine appropriate levels of performance and affordability.

Comment 7b. Runtime Target Should Not Increase

The four-hour minimum light output is still appropriate. Product improvements should be focused on light output and reliability rather than run time. Further, this increase in the Performance Target would require the most affordable quality lights on the market to either become more expensive or abandon meeting the Performance Targets. We prefer a customer-centric view whereby the benefits of evolving technology mean that the cost of the bare minimum standard product gets cheaper – i.e. more people can afford them – rather than change a system such that existing customers have currently purchased something “sub-standard.”

Response 7b.

Lighting Global decided that this was appropriate. While we feel that LED quality has increased substantially to the point where the minimum eligibility criteria for light output should be increased, we believe that a minimum four-hour run time is still appropriate as an eligibility criterion for consumer awareness programs.

Comment 7c. Same Light Setting Used for Both Run Time and Brightness Targets?

The suggested Performance Targets require a 5-hour run time and a 25 lm brightness (or 50 lux over an area of 0.1 m²); thereby it’s not entirely clear if the two indeed should be met simultaneously (i.e. 5 hrs @ 25 lm, or at least 25 lm and at least 5 hrs at some lower brightness).

A few currently approved devices don’t seem to simultaneously meet the (current) 4 hour criterion and the (current) 20 lm minimum brightness criterion. For example, the Solux LED 50 runs for 3.1 hr (not meeting the 4 hrs) at 68 lm or 24 hrs @ low setting. No intensity is specified for the low setting, but going by the duration in comparison to the high setting, the light output is most likely less than 20 lm.

Response 7c.

Thank you for noticing this omission. Just as in the previous Recommended Performance Targets, for a product to qualify for consumer awareness campaigns through Lighting Africa or Lighting Asia, the eligibility criterion for run time would need to be met at a light output that also meets the eligibility criterion for brightness (i.e. the two criteria would need to be met simultaneously at the same “specified light output”). In the final revision, we will include language to ensure that this requirement is included.

Results for the Solux LED-50 recently expired as the product finished testing in 2010. Though not fully documented in the Specs Sheet, on another setting, the product met both the brightness and run time Targets. We acknowledge that the way that information was reported was unclear, and we regret any confusion. We do welcome comments on any other currently approved products that do not seem to simultaneously meet these criteria.

Comment 7d. Use Brightest Setting to Assess Run Time Targets

The 5-hour solar run time Target and 10-hour autonomous run time Target should be met at the highest light level setting.

Response 7d.

As stated above, we will revise the language for the eligibility criteria to ensure that the run time criterion is met by a light level that also meets the criterion for light output. This does not need to be the “highest” setting, but would need to be a sufficiently bright setting that provides greater than 25 lumens or 50 lux.

Comment 7e. Increased Run Time Targets Will Increase Testing Time

The increased run time targets will increase testing time, which will increase the cost of testing.

Response 7e.

The amount of time this will add to testing is very small. At most this will require one extra hour of equipment time, but in many cases during testing there is much more than this amount of time with idle equipment in between tests. The difference in time will often be zero and – in cases where it is extended – the increase will not be very significant.

Comment 7f. Use Combined Measure (lumen-hour) for Brightness and Run Time

A measure which couples both brightness and run time, such as lm.hour, should be used in place of raising the Targets. The existing Targets could set a minimum bar for both measures, while a higher target of lm.hour could be used to raise the Targets. This measurement would allow for a shorter run time (but not less than 4 hours) in products with higher light outputs and vice versa.

Response 7f.

We plan to include the “lumen-hour” total lighting service metric on the next generation of Standardized Specifications Sheets. While this is a useful metric for comparing the total service, our market research indicates people value both run time and light output, and therefore a balanced approach is warranted. Products would not meet buyer expectations if they were very dim but lasted quite a long time or vice versa. In any case, as noted previously, the Targets will have a significantly reduced role in the Lighting Global quality assurance program.

Comment 7g. Report Performance Metrics Rather than Setting Targets

Rather than setting Targets, performance metrics should be reported and distributors/consumers can judge products accordingly. There are two different ways performance metrics could be presented:

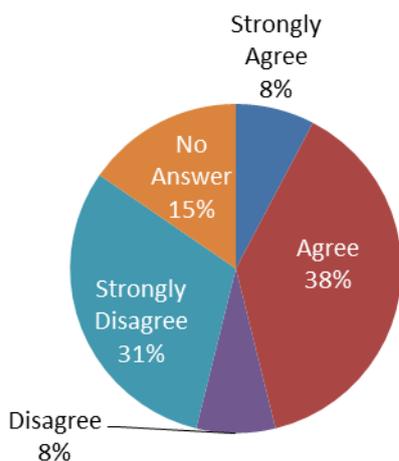
Banding: Banding is one possible response to this but would introduce some distortions where very similar products fall one side or the other of a banding limit. This is used for many domestic appliances in Europe.

Hard number: The most appropriate would be how many lumens -hours a product can deliver when full. This metric would vary over the life of the product, but as a “market place” comparison this is the most definite.

Response 7g.

We agree that the performance metrics should be reported so that distributors and consumers can make informed decisions. This approach will focus on communicating relative performance and verifying truth-in-advertising. We plan to still maintain eligibility criteria for Lighting Africa and Lighting Asia consumer awareness campaigns, but we will no longer advertise whether products meet the criteria. Over the next several months, we plan to engage in an additional discussion with industry stakeholders to determine the best way to present key performance metrics such as light output and run time.

8. Do you agree with the proposed changes to the Brightness Target?



Just as with the proposed changes to the run time target, respondents expressed mixed opinions about the proposed changes to the Brightness Target. The proposed brightness target is a higher target: Must have total output > 25 lumens or provide a minimum of 50 lux over an area of $\geq 0.1 \text{ m}^2$. Previously, products had to provide ≥ 20 lumens or ≥ 25 lux over a 0.1 m^2 surface.

Respondents also provided a variety of comments related to the proposed changes to the Performance Target for brightness. Some more general comments regarding Performance Targets as a whole were included in the comments following Question 1 about the Standards and Targets framework and Question 7 about the Run Time

Performance Target. Specific comments about changes to the terminology and values of the Brightness Target are presented here.

Comment 8a. “Brightness” or “Light Output”?

Notwithstanding the popular interpretation of the word brightness, this metric should be called “Light Output Target”, not “Brightness Target”. This standard is measuring the light output of the fixtures under test, not the “brightness”. Brightness is a perceived value, which includes effects of source size, background, spectrum, etc. Light output (in units of lumen) is the quantity of illumination produced by a light source and is measured by instruments only.

Response 8a.

You are correct that the more technical name for this Target should be “Light Output.” In our communication materials we’ve used the terms “Brightness” and “Light Output” interchangeably, but feel that brightness is often more colloquially well understood. We will continue to use the term “Brightness” in some documents.

Comment 8b. Multi-level Targets Based on Lighting Replacement

Considering the present LG product range there are clear differences in the use for which certain devices are intended: torches, true ambient lighting, desk / task lights and some “just lifting the dark” devices. These categories should have different minimum lighting requirements. Higher level products should have a higher target, such as a minimum of 150 lm for products with multiple light points. Others suggest that the target should be differentiated with a minimum of 40 lm for task lights and 100 lm for ambient lights (while the targets should be defined in terms of lumen-hours -- see Comment 8g).

Though it would likely be difficult to implement, one possible framework would be to make brightness targets dependent on whether the product is designed to replace a wick lamp or a hurricane lamp. Perhaps the manufacturer could let Lighting Global know upon sampling which type of fuel-based lamp the product is designed to replace and the product could pass based on either a replacing-a-wick-lamp brightness target or a replacing-a-hurricane-lamp brightness target. Then LG could write boldly on the passing product's SSS whether the the product is designed to replace a wick lamp or a hurricane lamp (and only products that are designed to replace a wick lamp are applicable to meet the replacing-a-wick-lamp brightness target).

Response 8b.

It is true that there are a wide range of light outputs and form factors across the products that have been (and will continue to be) tested by Lighting Global. While we appreciate your input on a potential framework

for setting light requirements based on the manufacturer's intention for the product (i.e., to replace a wick lamp or a hurricane lamp), this would be very difficult to implement (as you indicated).

Further, the Recommended Performance Targets framework for light output was originally developed with these differences in mind. The framework sets two types of requirements for illumination: One type is for absolute light output (i.e., luminous flux) while the other is for relative light output (i.e., illuminance from a particular distance). While any lighting product (regardless of its form factor) can pass the illumination Target by meeting either the luminous flux or illuminance requirement, the purpose for having the illuminance requirement is to ensure that products that are intended solely for task lighting purposes are still capable of meeting the Recommended Performance Targets. These products generally have a lower luminous flux than lighting products that are intended to be used as torches or room lights (and in some cases will not meet the luminous flux requirement); however, they may be able to meet the illuminance requirement depending on their design.

Additionally, as mentioned earlier, the Performance Targets will no longer be emphasized and will now be referred to primarily as eligibility criteria for consumer awareness campaigns. This use was the original intention for their purpose, but we will now more clearly present this message.

Comment 8c. Fieldwork Questions and Critiques

Several respondents provided critiques of or questions about the fieldwork used to determine the Recommended Performance Targets. These critiques are listed here:

- *Focus groups were asked to consider the performance of a \$12 lamp and were not asked to consider any price-performance trade-offs for an even lower-cost lamp, such as a top-selling \$8 lamp.*
- *In the focus groups most peoples' expectations were met with a light output of 25 lm for US\$12. They would likely not be happy with this same light output if the lamp cost US\$25.*
- *Focus groups were not asked about the use of different light settings at different times of the night or day. Products with multiple brightness settings still provide 5 hours of functional light, even if the brightest setting only runs for 3-4 hours. Some customers may prefer to have fewer hours on a high setting in exchange for extra brightness on this high setting.*
- *What was the reference for the target group? If their reference were the candles or kerosene lamps that are to be replaced, electrical lighting at something like 25 lm (2 candles) might easily be judged as "better" or sufficient, even though still very limited (and their satisfaction might not last long).*
- *How was the concept of ambient light understood? The dim light just lifting the dark or something more ambitious?*
- *Regarding the task lighting test, whether brightness is adequate (and thus satisfying) can only be properly assessed when dedicated tasks are actually performed (e.g. when "the needle is threaded"); were they? If not, the result might well be an underestimation.*
- *Results of both tests would also depend on color and structure (absorption) of surrounding surfaces (including the table top) as well as to the reflector of the lamp(s) – to which no reference is made.*
- *Illuminance measures were done, but – with regard to the task lighting test – no reference is made to such measurements being done over the minimum required surface.*
- *Generally, the large difference between these targets and recommended levels for task lighting in developed countries (for example the Netherlands) should be noted, where - depending on the task - levels of 200 – 800 lux are required (with 50 lux only considered enough for storage rooms and parking garages).*
- *With regards to the ambient lighting test, its indicated that an illuminance measurement was done plus the drive voltage noted; how was the brightness calculated from those? (i.e. if based on the voltage then why record illuminance, while if based on the illuminance, there'd be a substantial random error margin).*

Response 8c.

A number of these questions will be addressed in forth-coming reports presenting the results of the recent fieldwork in India. Direct answers to these questions are as follows:

In the focus group research, our primary goal was to determine the minimum performance requirements for a lamp at a price that a large portion of the market could afford. We realize that consumers would desire better performance from a more expensive lamp and may be satisfied with poorer performance from a less expensive lamp. This is part of the reason we have decided to deemphasize the Targets.

The multi-level and varied needs of consumers (e.g., bright light for chopping vegetables, dim light for preparing children for bed) is one of the drivers to deemphasize Performance Targets. We acknowledge that the way the focus groups were structured does not lead to a conclusion (one way or another) about the utility of lights that have varied brightness settings.

The reference point for baseline lighting varied by focus group participant. Most participants used hurricane lamps, simple wick lamps, candles, dry cell torches, homemade re-purposed LED lamps or a combination of these sources. We did not specify a reference for the focus group, but did ask participants questions about their common lighting practices in a survey questionnaire prior to the focus group.

The task light was described as a lamp used for reading, studying or selling goods, while the ambient light was described as a lamp for socializing and doing activities within the home. Participants were not asked to perform any tasks under either of these lights, but did understand how each lamp should be evaluated. Future studies could involve having participants complete tasks under the lights. Future studies would also take care to standardize the surface over which the tests were conducted. Though attempts were made to ensure the size of the room was characteristic of the area, the color and absorption of surrounding surfaces varied from group to group.

The vast discrepancy between baseline light levels in these target countries and common target requirements in more industrialized countries is precisely why Lighting Global chose to conduct these focus groups. Current preferences for light output are much lower in comparison to European standards, but they enable manufacturers to produce lamps that can satisfy a majority of customers at an affordable price. Our assumption is that as electric lighting improves and becomes more prevalent in these off-grid locations, the consumer's demand for higher-performing products will increase. Hopefully, gains in technology and efficiency will simultaneously enable manufacturers to produce these higher quality products at continually affordable prices.

During the sessions, two different measurements of light output were collected: Luminous flux and Illuminance. Luminous flux (reported in lumens) was inferred based on the driver voltage of the test lamp and calibration data. Each voltage level corresponded to a particular lumen level as determined by prior laboratory calibration. Illuminance on the task surface was measured directly with a light meter and reported in lux.

Comment 8d. Proposed Brightness Targets Not High Enough

Several respondents suggested that the current brightness targets were not high enough for today's market:

- *Basic mobile phones already offer torches with light output >25 lm, while grid-based lamps with 900 - 1000 lm are becoming standard. Nothing less than 100 lm should be supported for the rural market.*
- *The Light Output Target of 25 lm should be a Minimum Quality Standard; this performance level is easily achievable with current LED technology at a low price point.*
- *The Light Output Performance Target should be a minimum of 50 - 80 lm.*

- *Many available products already exceed 25 lm. To account for technology advances, the Target should increase to 50 lm.*
- *The Lighting Global memo states that the efficacy of LEDs has increased in the last 4 years from 40 lm/W to 100 lm/W, suggesting that the Targets should double or triple as well. According to the document, a 5-year revision interval is suggested; in line with the diagram on P 11 of the memo, by 2018 LED package prices will have dropped to approximately US\$ 1 for 200 lm/W efficacy; at such levels the currently proposed 25 lm target would be meaningless. Efficacies of presently LG-tested products range from roughly 25 lm/W to already as much as 150 lm/W (this is a rough estimation: luminous flux (lm) multiplied by autonomous runtime (hr), divided by battery capacity (V*Ah)). With such a large range of efficacies and efficacies well over 100 lm/W realistically possible, it seems justified to make the use of LEDs with efficacies at the lower end of the current range much more difficult by imposing considerably higher brightness standards.*

Response 8d.

We agree that higher light output targets are appropriate and achievable. Focus group research conducted in five countries in Sub-Saharan Africa and two Indian states suggests that a luminous flux Target of 25 lumens and an illuminance Target of 50 lux over an area of 0.1 m² results in widespread satisfaction among end-users (greater than 80% satisfaction across the focus groups that participated in the research). In addition, the brightness and run time Performance Targets are intended to be set at levels that a relatively low-cost product in the market could achieve. At this point, we believe 25 lumens and 50 lux strike this balance between product cost and consumer satisfaction.

Though we are deemphasizing the Targets, we will still maintain performance-based eligibility criteria for participation in the Lighting Africa and Lighting Asia supported consumer awareness campaigns. These eligibility criteria will incorporate the revised light output targets of 25 lumens or 50 lux.

Comment 8e. Only Use Luminous Flux (lumens), Not Illuminance (lux)

When testing for “brightness,” only luminous flux (reported in lumens) should be used rather than also measuring illuminance (reported in lux). The illuminance criteria also depends on the distance from the lamp, which must be specified. Also, as stated in the Lighting Global memo, with good optics, there is a nearly 1:1 correlation between luminous flux and illuminance, suggesting that illuminance has very little added value. Among the products currently tested by Lighting Global, only one appears to have met the Target based on illuminance testing alone. It seems that eliminating the illuminance measurement would pose very few negative consequences, while it would be more practical to only use luminous flux for measuring brightness.

Response 8e.

Measuring illuminance in addition to luminous flux allows the opportunity for lighting products intended for task lighting (e.g., a desk light) to meet the Performance Targets/eligibility criteria. Products that are intended to be used as desk lamps, for instance, do not need to provide the same luminous flux as products intended for room lighting. Therefore, the illuminance Performance Target is in place for those products whose main objective is to provide task lighting service, as opposed to ambient or concentrated torch lighting service.

Comment 8f. Raise Targets to Better Align with SE4ALL Requirements

It would be convenient for the Lighting Global Performance Targets to align with the recently released tracking framework for the United Nations’ Sustainable Energy for All (SE4ALL) initiative. Though SE4ALL does not specify a Light Output requirement, it does state that they must supply power exceeding 1 W for at least 4 hours and offer both task lighting and phone/radio charging. If one estimates that 1 Wh of the minimum 4 Wh is used for mobile charging, the remaining 3 Wh used with a 100 lm/W LED could produce 60 lm for 5 hours. For products which “meet the Lighting Global Recommended Performance Targets” to also be “countable under SE4ALL,” the Light Output Target would need to increase substantially (i.e. to >60 lm).

Response 8f.

Lighting Global agrees in principle with the SE4ALL metrics, but the performance of products is not yet at the level described in this comment. While LED chip-level efficacies have surpassed 100 lm/W in many cases, the system-level efficacy that includes other sources of loss along with the light source efficacy remains lower. The average system efficacy for products that pass the Lighting Global Standards is currently approximately 40 lm/W. This places the originally proposed Targets in line with SE4ALL recommendations, since it means approximately 120 lmhr can be produced with 3 Wh of solar energy and the proposed Targets would have required 125 lmhr. The revised eligibility criteria will only require 100 lmhr, which is somewhat lower than the SE4ALL value (assuming a system level efficacy of 40 lm/W). As technology improves, more and longer-lasting lighting will be possible with the same solar power input. This is a fundamental issue with the SE4ALL metrics as they are currently framed, as it would suggest a constant PV power is needed instead of a constant level of service. We expect this will be addressed as the metrics evolve with experience applying them to markets for technology like off-grid lighting.

Comment 8g. Use Combined Measure (lumen-hour) for Brightness and Run Time

A measure which couples both brightness and run time, such as lumen-hour, should be used in place of raising the Targets. The existing Targets could set a minimum bar for both measures, while a higher target of lm.hour could be used to raise the Targets. This measurement would allow for lower brightness in products with longer run times and vice versa. Recommended Performance Targets should be 200 lumen-hours for task lights and 500 lumen-hours for ambient lights. Minimum brightness measurements should be 40 lm for task lights and 100 lm for ambient lights with a minimum run time of 4 hours.

Response 8g.

As noted in response to a similar comment regarding the run time target, there is a plan to include the “lumen-hour” total lighting service metric on the next generation of Standardized Specifications Sheets. While this is a useful metric for comparing the total service, our market research indicates people value both run time and light output, and therefore a balanced approach is warranted. A product would not meet buyer expectations if it were very dim but lasted quite a long time or vice versa.

9. Do you have any additional questions about the Lighting Global Minimum Standards and Performance Targets Update 2013 or questions about our Stakeholder process?

Stakeholders provided a number of other comments about the proposed updates to the Minimum Quality Standards and Recommended Performance Targets. As above, in some cases the comments listed here are edited versions of 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. In cases where substantial text was removed from the comment, the Lighting Global team reviewed the text of the full comment and only included the core of the argument here for brevity. Comments are included below with responses from the Lighting Global team.

Comment 9a. Test Complete System Rather Than Components

We think it would be valuable to test the complete lighting system (including lighting, battery and all components) rather than compartmentalized component testing. If the goal is to identify early failures, this could be achieved by testing the complete system and diagnosing failures as they occur. The component testing method introduces uncertainties in the test given the need to modify the system as components are dis-assembled and re-assembled.

Response 9a.

The test methods that are used by Lighting Global do include a number of system-level tests. We understand the concern with disassembling and reassembling products in order to be able to test them; however,

certain test procedures would not be possible without performing compartmentalized testing. Furthermore, the Lighting Global Quality Assurance program is in place to protect consumer interests by not only identifying early product failures but also ensuring that products perform at or above their advertised specifications.

Comment 9b. Ban AGM Batteries

We should also ban Absorbent Glass Mat (AGM) batteries from systems that are smaller than 10 Wp systems. The minimum standard should instead require sealed-lead acid (SLA) batteries to be gelled-electrolyte (GEL) batteries. The failures of AGM batteries will partly be addressed by the battery durability test, but there is still the sulfation problem. This problem will make systems in the field fail quickly: People commonly use their systems in a partly discharged mode instead of making sure that the batteries are fully charged at least once every 1 or 2 weeks. Sulfation degrades the battery and cause it to have a shorter lifetime.

Currently, a system with an AGM battery (as long as it passes the tests) is basically seen as the "same quality" as a similar system with a lithium-iron phosphate (LiFePO₄) battery. Customers who don't know the difference, will think both products offer a similar lifetime, while the second system will potentially last 5 times longer. Further, even though GEL SLA or LiFePO₄ batteries are typically more expensive, because AGM batteries need more complicated charge control algorithms, the prices of the end-product will not differ much.

Response 9b.

Aside from the issue of hazardous substances, as a program, we strive to be technology neutral. With this in mind, we expect the new battery durability test will address the sulphation problem. Details on the battery durability test are outlined in IEC 62257-9-5 Annex BB. In these methods the sealed lead-acid battery is discharged to a voltage of 1.8 V/cell and then stored for 30 days at 30 °C ± 5 °C connected to a resistor which causes a deep discharge. The battery capacity is measured before and after for comparison. Similar tests, with different parameters, are conducted for each of the different battery types. These tests should assess problems related to deep discharge and sulfation.

There is a great diversity in product quality and performance even among those that pass the Minimum Standards (which we emphasize here are *Minimum* and not the ceiling). It is up to manufacturers to highlight and communicate the aspects of their product that differentiates it from others in the market.

Comment 9c. Add Standard for Standby Loss

Lighting Global should add a standard for a product's standby loss. This is a measurement that the labs already test. If a product has a high standby loss, then much of the energy that went into charging the product is lost from the product's parasitic load. This is unfortunate for the user. Also in cases where the battery chemistry is affected by being stored at a low voltage (e.g. SLA), a high standby loss could be detrimental to the product's lifetime.

Response 9c.

We feel it is too late to include this in the current round of revisions of the Standards, but do agree that it should be considered for upcoming revisions. In the interim, we will work on determining an appropriate threshold for this standard.

Comment 9d. Concern about Weight of Industry Voice in Process

We realize Lighting Global has had extensive discussions with industry even about the existing (lower) standards and targets. We want to encourage academic and public sector bodies to campaign for a continuous improvement process for quality. This process of maintaining and improving quality of PV-powered products should not only be the task and under the leadership of the industry! With increasing

markets and a fast-growing industry we see the risk that this process will be more and more driven by industry alone. We would appreciate very strongly to continue to have an open discussion between all stakeholders (industry, researchers, implementing bodies, testing labs and, of course, customers).

Response 9d.

We agree that it is important to maintain an open and inclusive stakeholder process with broad participation.

Comment 9e. Include Mobile Charging Capacity on Specs Sheets

The spec sheets should also indicate the actual possibility of charging a telephone or radio in addition to meeting minimum lighting requirements. The spec sheets currently indicate whether the product offers a connector for mobile phone charging, but for some products, the available electricity may not be sufficient to charge a phone in addition to maintaining minimum lighting requirements. In some cases, the size of the PV panel may be the limiting factor, while others may be limited by the storage capacity of the battery.

Ideally, the spec sheet would state how much electricity is available for powering other devices (in Wh) beyond providing minimum lighting services and/or would state whether a phone can be regularly charged off a system without jeopardising minimum lighting (for this measure, 1 Wh/day seems appropriate to account for charging a phone).

Response 9e.

We have been considering how to incorporate an assessment of the mobile charging capability of the products in the test methods. Including a metric such as the one you propose would be a logical initial step. We do not feel that we can make this change at this time, but will consider this for future revisions. Currently the revised spec sheets will indicate that the stated "...run time estimates do not account for mobile charging or other auxiliary loads."

Comment 9f. Recommendations for Appropriate Products

Considering the realities of the market, with extreme difficulties in logistics, delivery and administration, products must be designed to meet the needs of BOP customers. These are a series of recommendations for appropriate products:

- *provide power greater than 1 Wp*
- *offer mobile charging direct from the panel (if mobile charging is an option)*
- *use LEDs with a rated lifetime of >20,000-hours*
- *provide a light output of >100 lumens*
- *use LiFePO4 batteries that are >2 Ah and rated for more than 1000 cycles*
- *offer a guarantee of > 1 year with simple, free replacement*
- *require minimal maintenance or be maintenance-free*

Response 9f.

Though we cannot include or endorse all of these in the current Standards and Targets, we are including this list of product qualities here so that other stakeholders may see your recommendations. As a program, we are focused on "truth-in-advertising" and minimum quality standards. As a rule, we do not attempt to tell companies how to design products.

Comment 9g. Importance of "Repairability"

There is no mention of reparability - this is a serious omission. It should be possible to repair any lantern with basic tools. Batteries, solar panels, printed circuits should all be replaceable with no more than a soldering iron and screwdriver. All electronic components likely to fail should be pin-through-hole, not surface-mount. Every lantern should contain a circuit diagram. A troubleshooting and service manual should be widely

available. A recommended list of spares should be published, and updated in the light of experience. This is really important.

Response 9g.

We agree that ease of repair and access to spare parts are important characteristics for off-grid lighting products. Moreover, many end-users have indicated they are very interested to purchase products that are repairable. Nonetheless, we are not including a requirement for ease of repair in the minimum quality standards. We believe that this aspect of product design should be left to the individual companies, as some companies prefer to make their products more tamper resistant and tamper-evident to increase the likelihood that customers will only have the lamp repaired by trained technicians through the warranty process.

We also appreciate your suggestions that companies provide circuit diagrams, troubleshooting and repair manuals along with a list of recommended spares. These are in line with suggestions we have heard from local electronics technicians who are already repairing these lanterns, but frustrated by the lack of spares and information.

Comment 9h. Changes to Standards May Create Uneven Market

Upping quality thresholds is welcomed. We have some concerns over the transition period of requirements creating an uneven market between those manufacturers whose lights have already achieved approval (which remains valid for two years) and new manufacturers of products.

Response 9h.

Our proposal is to grandfather in products that have met the Minimum Quality Standards prior to this update and whose test results are still valid after the updated Minimum Quality Standards and Recommended Performance Targets are in place. However, any product testing that occurs after the updated Standards and Targets go into effect (January 1, 2014)—including test results renewal testing and market check testing—will be subject to those updated Standards and Targets. While we understand the concern about an “uneven market”, we also believe that it is important to provide a stable quality assurance framework for manufacturers. It would be unfair to prematurely revoke the status of products before the two year expiration of results for tests that occur before the new requirements are in place.

Comment 9i. Solar Lights Analogous of Mobile Phones

Have you carefully considered the technological shift of the mobile phone products, why they achieved widespread dissemination in Africa?

Response 9i.

Yes, this is a common product class and one to which solar lighting is often compared. We view it as an interesting and informative case study on technology adoption.

Comment 9j. Tested Products Obsolete

Do you know that most of the Lighting Africa certified products are already obsolete, and good for nothing, even before they hit the local market? BOP customers may be poor but not stupid. They already paid COD, often even in advance, for quite sophisticated and expensive mobile phone in hundreds of millions in Africa.

Response 9j.

We disagree and feel that many products which have met the Minimum Quality Standards are competitive in the market.

Comment 9k. Effect of Multinationals Involved in Off-grid Lighting

Have you considered that, because of increased awareness of the huge market potential, more multinationals are getting involved also in the lighting (and pico lanterns) market? Companies like: Philips, Schneider Electric, Panasonic, etc... are also coming with their RD (Research and Development) power . Where do you think the BOP lighting market will likely go, sooner or later?

Response 9k.

Yes. We have tested products by a number of large multi-national companies. We agree that if these large companies focus their attention and R&D on pico-solar technologies, significant advancements could be made, but simultaneously believe that smaller, dedicated companies can make and have made a significant contribution to the off-grid lighting market.

Comment 9l. Product, Supply or Distribution?

Where is then the problem at this stage: the product, the supply or the distribution? Could, again, the dissemination of mobile phones serve as best practice to follow?

Response 9l.

None of the above are “problems,” yet all are challenges. Products are continually improved, while regulation helps ensure that a minimum level of product quality is maintained. Manufacturers are continually searching for new ways to lower costs, improve manufacturing practices and export products to provide a reliable supply. Each country faces their own challenges with effective distribution of pico-solar products and distributors are creating new models to meet these challenges. The dissemination of mobile phones, though not completely analogous, offers many insights that should be considered.

Comment 9m. Allow Competition in Market

BOP customers are ready with their "real" money. Are we good enough to provide them with and deliver "the right product," at a competitive price? When is that NGOs will leave it to the market, and encourage competition to take hold?

Response 9m.

With over 60 companies and 100 different products tested by Lighting Africa/Lighting Global in the past three years, it appears that competition has taken hold and companies are working to produce quality products targeted at BOP customers. While not all markets are equally competitive, we anticipate that the level of competition in the off-grid lighting market will continue to increase in most regions of sub-Saharan Africa.