Lighting Global Quality Assurance Framework
Past, Present, and Future Support for the Off-Grid Energy Market

Version 4
September 2016

Executive Summary

This document **describes the framework and intentions of the Lighting Global Quality Assurance (QA) program.** It also explains how Lighting Global currently interacts with the regional programs (i.e. Lighting Africa and Lighting Asia) and how the Global and regional programs interact with manufacturers, distributors, customers, and other stakeholders. It concludes by **identifying challenges that the QA program should address to respond to changing market conditions** and **the actions the program is taking to address these challenges**. These challenges and actions have been updated in this version to reflect the state of the program and the market in September 2016.

The Lighting Global QA program is designed to support the development of markets for modern off-grid lighting and energy systems. The program provides buyers with reliable technical information and connects them with manufacturers and sellers of quality-verified products. Our approach includes testing and verification of quality and performance and engagement with the diverse and fast-growing market for modern off-grid lighting and energy systems, through stakeholder consultation and field research. The QA program historically supported pico-powered lighting and energy products that include solar modules up to 10 watts (W) in size and has now expanded to support "plug-and-play" direct current (DC) solar home system kits that use solar modules ranging from 10 W to 100 W in size. Additionally, the program is in the process of extending to cover SHS with solar modules up to 240 W in size.

The QA program has five **guiding principles**, driven by the needs of the market:

- **Affordability:** Seek an appropriate balance between quality and affordability for a market consisting primarily of low-income off-grid consumers.
- **Diversity & Innovation:** Allow for product diversity in technology, utility, and price; encourage innovation by using non-prescriptive, performance-based metrics and goals.
- **Rigor:** Develop rigorous test methods that can be carried out using reasonably low-cost instruments; provide technically valid test results that can be accepted globally.
- **Stability:** Maintain stable and transparent QA policies so stakeholders know what to expect.
- **Insight:** Effectively communicate key product quality and performance information so buyers can make informed purchasing decisions.

The QA framework has actively supported the market for modern off-grid lighting and energy systems since 2009. Today, in 2016, the framework includes a third-party product testing and verification program, product quality standards, a standardized specifications sheet (SSS) communication tool, the Technical and Eco-Design

Notes series, and an IEC Technical Specification (TS 62257-9-5) that helps to enable wider adoption of the framework. Additionally, the QA team has developed a set of test methods to extend support to solar home system kits up to 240 W in size. These methods are already in use by the Lighting Global program and will soon be submitted for incorporation into IEC TS 62257-9-5.

As the QA program enters its seventh year, Lighting Global continues to work on **improvements** to the framework, ensuring its continued relevance for the rapidly changing off-grid solar lighting and energy products market. Key recent activities aimed at improving the program include the following:

- **Shortening the testing process:** Lighting Global has developed a shorter method that relies on LM80 data and a 500-hour driver test to assess lumen maintenance. The lumen maintenance test has historically been the single test that required the longest time (between 1.5 to 3 months); thus providing a shorter alternative for eligible manufacturers will help to reduce the overall testing time. Lighting Global has also implemented a new, faster framework for product quality verification called the Accelerated Verification Method (AVM). This is an optional, alternative quality verification pathway for eligible manufacturers that is faster than the standard Quality Test Method (QTM) pathway, while maintaining the rigor and value of Lighting Global QA. Additionally, Lighting Global is continuing to seek opportunities to shorten the verification process to enable quality verified products to enter the market more quickly.

- **Expanding the scope:** Lighting Global has extended support to "plug-and-play" direct current (DC) solar home system kits from 10 W to 100 W in size. A further extension to SHS kits with modules up to 240 W is in process. Larger systems are increasingly a priority for the off-grid energy systems market. These systems have the capacity to support a range of appliances beyond lighting and mobile phone charging. Additionally, with the rise of pay-as-you-go (PAYG) or fee-for-service products in the market, Lighting Global has expanded the test methods to provide a simple pathway for products adding PAYG features to meet the Quality Standards.

- **Improving communication to buyers:** Lighting Global recently implemented a policy on performance reporting that requires manufacturers to display key performance information on the packaging for all quality-verified products. These reporting requirements, along with other activities, are intended to increase buyers' access to consistent and comparable information about product performance.

- **Engaging with government standards organizations:** Governments throughout Africa and Asia are beginning to adopt standards for solar lanterns and solar home system kits. Lighting Global is working with government standards bureaus to ensure that government standards are harmonized with the existing Lighting Global QA framework.

- **Addressing intellectual property ownership:** Lighting Global has implemented a policy aimed at addressing counterfeiting and other violations of intellectual property ownership. The policy requires companies to pledge that they have not (and will not) violate the intellectual property of another entity in the context of product testing agreements. Moreover, Lighting Global reserves the right to refuse to test products if they are submitted by a company that has been determined, through an appropriate court decision, to have violated the intellectual property of another organization or person. The policy also allows delisting of products that are already quality verified if a legal decision indicates an IP violation has occurred.

- **Preparing for the future:** Lighting Global is working to expand the network of commercial test laboratories, engage with key stakeholder organizations, and develop a strategy and business model to ensure effective quality assurance services are maintained on a sustainable basis beyond the end of progammatic World Bank Group funding for Lighting Global.

Program History

Institutional Support: The Lighting Global quality assurance (QA) program was originally developed in support of Lighting Africa, a joint program of the World Bank and the International Finance Corporation (IFC). Lighting Africa activities began in September 2007 with the aim of improving access to clean, affordable lighting in Africa. Since then, QA continues to be a collaborative effort that is executed by internal World Bank and IFC staff, external consultants, and a broad set of stakeholders who contribute to and adopt the principles of the QA framework. With the launch of the Lighting Asia/India program in 2012, the Lighting Global program was spun off from Lighting Africa to administer the common, global aspects of the Africa and Asia initiatives, including the QA program. Lighting Global is now supported through collaboration between IFC, the World Bank, and the United States Department of Energy. Lighting Global currently supports program activities in more than 15 countries through Lighting Africa, Lighting Asia, and associated country-level programs.

Snapshot of Activity: Since the launch of Lighting Africa, the QA programs' network of test laboratories, currently consisting of labs in the U.S., Germany, India, Kenya and China, have tested over 200 products using the full Quality Test Method, 145 of which have met the Quality Standards and received program support. Many additional product tests have been conducted using the Initial Screening Method, the Market Check Test Method, and Associate Renewal testing. This work has helped enable over 20 million units of quality-verified products to be sold in Africa, Asia and the Pacific through June 2016. In April 2013, the test methods developed by Lighting Global were published by the International Electrotechnical Commission (IEC) as IEC TS 62257-9-5, Edition 2.0. These test methods were recently updated through IEC to Edition 3.0 in June 2016. The QA framework utilized by Lighting Global has been adopted by a number of governments and programs, including bureaus of standards in Kenya and Ethiopia and country level programs such as the Infrastructure Development Company, Ltd. (IDCOL) of Bangladesh, the Alternative Energy Promotion Centre (AEPC) of Nepal, and others. Adoption of the framework is under consideration by a number of additional governments, including Tanzania, Uganda, Pakistan, and Afghanistan. Additionally, it is anticipated that ECOWAS, which includes 15 member countries in West Africa, will adopt a quality assurance framework that is largely (but not fully) harmonized with the Lighting Global QA framework in the coming months. Lighting Africa and Lighting Global have also held two Outstanding Product Awards competitions, in 2010 and 2012. In addition to the QA activities, Lighting Global has published a series of 28 Technical and Eco-Design briefing notes, providing detailed technical and environmental insights into product components used by the off-grid lighting industry. Further, Lighting Global has conducted field research regarding product availability in the market, consumer preferences related to product performance, service and maintenance issues relevant to the off-grid lighting industry, flow of information about quality in the product supply chain, and the emergence of pay-as-you-go sales models.

Lighting Global QA Program Today

Quality assurance (QA) is a key component of Lighting Global and its associated regional programs. The widespread adoption of the Lighting Global QA framework provides benefits to multiple stakeholder groups:

- **Manufacturers** can have their products tested and verified through a single framework, thereby saving time and money,
- **Supply chain actors** (wholesale distributors, retailers, bulk buyers, financial institutions, etc.) can make more informed purchasing decisions and marketing campaigns, while only needing to understand one QA framework,
- **Standards agencies** benefit from adopting an internationally recognized QA framework that gives a high degree of legitimacy and alleviates the need for new in-country testing,

- **Consumers** have access to better quality products. Additionally, consumers can benefit from lower product prices, as companies can pass savings of reduced costs for QA verification onto customers.

As shown in Figure 1, the Lighting Global QA framework consists of three key main components: test methods and quality standards; testing and verification; and communication to stakeholders. These components are described in more detail below.
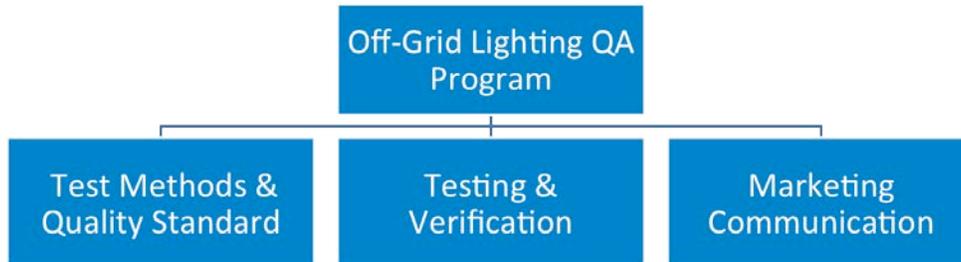

Figure 1. Structure and main components of the Lighting Global QA framework (based on a diagram prepared by Navigant Consulting, Inc., under activities sponsored by the U.S. Department of Energy's Global LEAP initiative).

Test methods and quality standards

Lighting Global has developed four test methods to meet the unique needs of stakeholders in the market for off-grid lighting products. These methods are faster and less expensive (lower personnel and equipment costs) but less thorough than other established test procedures for lighting products. The test methods, summarized in Table 1, assess the performance of individual components such as the LED, battery, and PV module, as well as system-level metrics such as run time, physical ingress and water protection, and durability.

Table 1. Summary of key tests used by the Lighting Global QA Program.

Component Tests	**Sampling**	• Randomly selected from warehouse or marketplace
	Photometrics	• Luminous flux (lumens—total light output) • Standardized distribution (illuminance)
	Battery & Charge Control	• Battery capacity (amp-hours) • Protection (voltage cut-offs and durability)
	Solar Module	• Power output (watts) • Current-voltage characteristics (I-V curve)
System Tests	**Full-Battery Run Time**	• Measured using standardized cycle (hours of operation)
	Solar-Charge Run Time	• Modelled estimate (daily hours of operation after solar charging)
	Energy Service Calculations	• Modelled estimate (daily energy and hours of operation for systems with appliances)
	Physical Ingress & Water Protection	• Incorporates enclosure (IP class) and system-level protection (coatings, etc.)
	Ports and Protection Tests	• Evaluates the function, safety and efficiency of ports in the system and ensures the product has adequate overcurrent protection (currently required for SHS kits, but may soon apply to pico-products with ports as well)
	Durability	• Drop test from one meter (pass/fail) • Switch and connector durability • Internal wiring and solder inspection • Lumen maintenance • Battery capacity loss after storage

The QA framework and test methods for pico-products (products with solar modules smaller than approximately 10 Wp) have been institutionalized through, and are now based on, IEC TS 62257-9-5, Edition 3.0, a Technical Specification published by the International Electrotechnical Commission (IEC). Publication of this document through IEC provides a common framework that can be used to enable widespread adoption of a harmonized quality assurance approach. The document was published in a way that enables revision on a reasonably frequent basis (i.e., every one to three years). This was done to help ensure that the quality assurance

framework and test methods can be updated to meet the needs of a rapidly changing market. The methods for solar home system kits will likely be incorporated in IEC TS 62257-9-5, Ed. 4.0 in 2017.

Lighting Global currently uses six test approaches, all of which are described in IEC TS 62257-9-5 and the Lighting Global Quality Assurance Protocols for Solar Home System (SHS) Kits:

- The **Quality Test Method (QTM)** is the flagship method for Lighting Global. The results are used to verify if products meet the Lighting Global Quality Standards, to verify manufacturers' claims, and to provide input information for the Standardized Specification Sheets that are published through the Lighting Global website. Having a quality-verified product is a pre-condition for manufacturers that wish to achieve Associate Status with the Lighting Global, Lighting Africa, and Lighting Asia programs.
    - o 18 product units are randomly selected from a warehouse at the product's assembly location or in the commercial market. (For SHS kit products, 16 product units are selected).
    - o A sample size of 6 is used for most tests; Lighting Global aims to provide results from these tests in approximately 4 months from the time that samples arrive at the test laboratory. (For SHS kit products, a sample size of 4 is used).
- **Renewal testing** is required after two years for products that meet the Lighting Global Quality Standards. If the product's design has not changed, it can be renewed using an abbreviated version of the QTM test that uses a smaller sample size. Most of the test procedures used are identical to QTM testing, except that the lumen maintenance test is shortened to 500 hours (from 2000 hours).
    - o 6 product units are randomly selected from a warehouse at the product's assembly location or in the commercial markets.
    - o A sample size of 2 is used for most tests; the target timeline for completing tests and delivering reports is 2 months from the time that the samples arrive at the test laboratory.
- The **Initial Screening Method (ISM)** is an abbreviated version of the QTM that is designed to provide a lower cost and faster turnaround than QTM testing. The ISM provides rapid feedback about emerging products for manufacturers, distributors, government agents, and NGOs and offers a low-cost assessment of a new product's likelihood of passing the full QTM. This screening can also assist companies with ongoing product research and development. The ISM is not designed as an end in itself.
    - o 3 or 4 product units are selected by companies themselves and are provided for screening.
    - o A sample size of 1 is used for each test; Lighting Global aims to provide results from these tests in approximately 6 weeks from the time that the samples arrive at the test laboratory.
- The **Market Check Method (MCM)** uses test methods that are very similar to the ISM, but samples are obtained from the retail market and the sample size for each test can range from 1 to 6 depending on the objective of the test. This test is used to confirm whether quality-verified products (i.e. products that have met the Lighting Global Quality Standards according to QTM testing) continue to provide the same level of performance over the two-year validity of the test results.
- The **Accelerated Verification Method (AVM)** is an optional, alternative quality verification pathway to the QTM that is designed to reduce the initial testing time from about four months to approximately eight to ten weeks. Time savings come from (i) reducing the number of samples required for testing from 18 to 6, (ii) shortening the period for lumen maintenance testing, and (iii) eliminating third-party sampling. The AVM uses a two-stage testing process to enable eligible products to enter the market faster. Products must first be tested using an ISM with a sample size of 2 to verify if products meet the Lighting Global Quality Standards and qualify for program support. Within six months of the product entering the market, the product is then randomly sampled (either from the warehouse or directly from

the market) and assessed using a full QTM test. The time savings from the AVM are possible due to the three main elements of the AVM:
- o Eligibility based on the manufacturer's strong history of success with the Lighting Global QA program.
- o Expedited verification entry testing.
- o Strong incentives for compliance through mandatory follow-up QTM tests and penalties for poor QTM or market check test results.

- A sixth test method, called the **Pay-as-you-go (PAYG) Method** has been developed by the Lighting Global team and is in the process of being incorporated into IEC TS 62257-9-5. This method offers targeted testing of fee-for-service or PAYG-enabled versions of products that previously qualified for market entry or market support programs through the process of QTM or AVM testing. The evaluation of the PAYG aspects of the products is limited by design, and the PAYG specific tests can generally be completed in about one week. Targeted testing is conducted on two samples provided by the manufacturer and consists of the following tests:
  - o Visual inspection, including internal assessment,
  - o Durability testing on any aspects that may have been impacted by the addition of the PAYG option (e.g., new ports or changes to the existing casing),
  - o An estimate of the parasitic consumption or additional standby loss due to the addition of the PAYG option,
  - o Submission of manufacturer declaration indicating that the performance of the PAYG enabled version is equivalent to that of the previously tested non-PAYG product,
  - o In cases where PAYG-enabled versions of products are similar, but not identical to the previously-tested non-PAYG version, only those aspects which differ need to be tested, rather than requiring full testing of the entire product.

Products must meet the **Quality Standards** to be eligible for services from Lighting Global and the associated regional programs. As of September 2016, the following requirements constitute the core of the Lighting Global Quality Standards for pico-products:

- **Truth-in-advertising:** accurate consumer-facing labeling (e.g., rated run time, light output, battery capacity, PV power)
- **Lumen maintenance:** after 2,000 hours, the product's light output must not drop below 85% of the initial value (alternatively, products may meet this requirement by achieving 95% of the initial light output after 1,000 hours)
- **Battery:** must be durable and adequately protected
- **Health and Safety:** batteries may not contain mercury or cadmium; products are safe
- **Durability and quality:** products are designed and manufactured to avoid early failure
- **Warranty:** products have a consumer-facing warranty with at least one year of coverage
- **Performance Information:** Product packaging reports run time and brightness along with a note about the impact of mobile phone charging

The Quality Standards for SHS kits are similar, but they include additional requirements regarding the voltage range of the ports, length of the warranty, and information that must be included in the user manual.

Testing and verification

The testing and verification activities carried out by Lighting Global are based on the test methods described above. Tests are currently conducted at six independent test laboratories, with additional labs in the process of being added to the network (Table 2). To conduct QTM and Renewal tests of pico-solar products, test laboratories must be ISO 17025 accredited to conduct tests according to IEC TS 62257-9-5.

Table 2. Test labs in Lighting Global network

Test Lab and Location	Approved Tests and Roles
Schatz Energy Research Center (SERC) **Arcata, California, USA**	*Conduct QTM, Renewal, ISM, and MCM tests for pico-solar products and SHS kits *Manage test lab network *Train new labs *Coordinate development of test methods/updates to IEC specification
Fraunhofer Institute of Solar Energy (FISE) **Freiburg, Germany**	*Conduct tests on SHS kits *Train new labs *Aid in development of test methods/updates to IEC specification
Shenzhen Academy of Metrology and Quality Inspection (SMQ), Shenzhen, China	*Conduct QTM, Renewal, and ISM tests for pico-solar products and SHS kits
University of Nairobi Lighting Laboratory **Nairobi, Kenya**	*Conduct ISM and MCM tests for pico-solar products
The Energy and Resources Institute (TERI) **New Delhi, India**	*Conduct ISM and MCM tests for pico-solar products *Plan to conduct QTM tests for pico-solar products
Ethiopian Conformity Assessment Enterprise (ECAE)	*Soon will conduct ISM and MCM tests for pico-solar products
Intertek Hong Kong **Hong Kong, China**	*Soon will conduct QTM, Renewal, and ISM tests for pico-solar products
TUV-SUD **Shenzhen, China**	*We anticipate that they will conduct QTM, Renewal, and ISM tests for pico-solar products starting in 2017

NOTE: The Lighting Research Center in Troy, New York, USA and the Fraunhofer Institute for Solar Energy Systems in Freiburg, Germany conducted valid QTM, ISM and MCM testing for Lighting Global between 2009 and 2015.

Figure 2 illustrates how the QTM and ISM tests are used when a company wishes to test a new product. The manufacturer has the option of either testing their product initially using the lower-cost ISM testing or forgoing the ISM entirely and testing their product with the full QTM testing. Eligible companies may also opt to test their products using AVM testing instead of QTM testing. If the QTM or AVM testing shows that the product meets the Quality Standards, the product receives a Standardized Specification Sheet (SSS) and is listed on the Lighting Global website as a quality-verified product.

Regardless of whether the product meets the Quality Standards or not, the manufacturer receives a detailed test report with qualitative and quantitative test results and feedback on how the product could be improved. If the product does not meet the Quality Standards, Lighting Global will work with the manufacturer to resolve the issue. Depending on the nature of the failure, this process may be as simple as changing product labeling and

advertising materials. If technical design changes are necessary, depending on the extent of the changes, the manufacturer may be able to resubmit their product for partial re-testing at a lesser cost than full QTM testing. In some cases, depending on the nature of the design changes, full re-testing may be required.
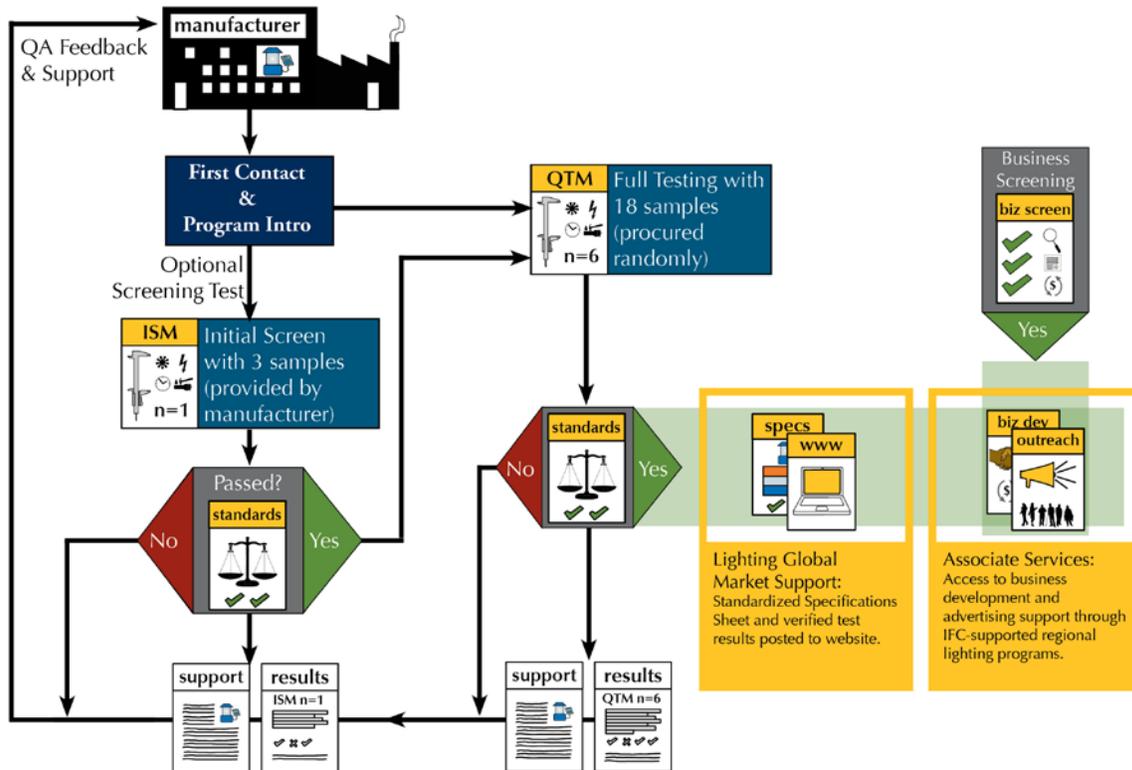

Figure 2. Process for manufacturer engagement and new product testing for pico-products. The same processes will apply for SHS kit products, although the initial screening would be conducted with 4 samples and the full testing would be conducted with 16 samples for a sample size of four.

Once a manufacturer has at least one product that meets the Quality Standards, they may apply to become a program Associate. Associates are eligible for business development services and outreach campaigns conducted by country programs associated with Lighting Africa and Lighting Asia. To become an Associate, the company must pass an integrity due diligence screening conducted by IFC. Associate services are determined by the regional/country programs and are tailored to the specific needs of local markets.[1] These services may include:

Marketing

- Associate companies profiles are featured in the Associates Section on the Lighting Global website and, with upcoming website revisions, products will be highlighted in the Products Section.

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[1] Lighting Africa and Lighting Asia country programs may charge fees to Associates in exchange for country or region-specific business support services.

- Associate products may be featured in the scrolling banner on Lighting Global, Lighting Africa and Lighting Asia websites and their "development impact stories" are featured in the newsletter and other program publications such as reports.

Business development services

- Advance access to publications regarding industry trends and market opportunities.
- Guidance on product development based on market, consumer and technical reports.
- Guidance on product lifecycle, recycling and other sustainability issues facing the industry.
- Account management, including regular meetings to discuss business strategy, market developments and emerging business opportunities.
- After-sales service & maintenance training provided for wholesalers and retailers.

Business linkages

- Invitation to trade fairs, exhibitions, conferences, seminars and awards.
- Notification of opportunities for grants, investment and loans.
- Introduction of Associate quality verified products to bulk buyers.
- Business-to-business matchmaking with distributors, and other stakeholders along the supply chain.

Consumer Education

- Invitation to participate in country-based consumer awareness campaigns and regional marketing programs (e.g. road shows, forums, exhibitions etc.) to increase product awareness and sales.
- These campaigns may also include substantial above-the-line media coverage featuring quality-assured products offered in tandem with Associates own marketing efforts.
- Access to negotiated media discounts for advertising related to the consumer education activity.

Market Intelligence

- Reporting on country level product sales performance / market share.
- Access to distribution, marketing and sales reports.
- Country level information on ease of doing business and market potential.

Access to Finance facilitation

- Working capital and credit lines developed for manufacturers, importers and distributors.
- Introduction of the Associate to microfinance institutions to facilitate financing options at a consumer level.
- Introduction of the Associate's distribution partners to local financial institutions.

Figure 3 illustrates how a manufacturer maintains their products' quality-verified status. Periodically, without notice to the manufacturer, each product may undergo market check testing, in which samples are procured from local retail markets and tested using the Market Check Method. The test results are compared to the product's advertising materials and the Lighting Global SSS; any discrepancies result in a re-test with a sample size of six per test to confirm the problem (or a sample size of four in the case of SHS products). The cost of secondary

market check testing (i.e. the re-test) must be borne by the manufacturer. The samples for re-testing may be obtained from the retail market or random warehouse sampling at the discretion of the Lighting Global program. For products quality-verified through the proposed AVM testing, a follow-up QTM test of each product is guaranteed within six months of the product being launched in the market.

If a manufacturer wishes to maintain the quality-verified status of its product after two years, re-testing with randomly selected products is required. If the product under consideration for renewal is identical to the original product (i.e. no significant design changes have been made), then a renewal test with a sample size of two may be used (at least six units of the product are required to complete this testing). However, if significant changes have been made to the design, full QTM testing of any aspects that have changed is required. In any case, if re-testing shows that the product no longer meets the Quality Standards, the product loses its quality-verified status.
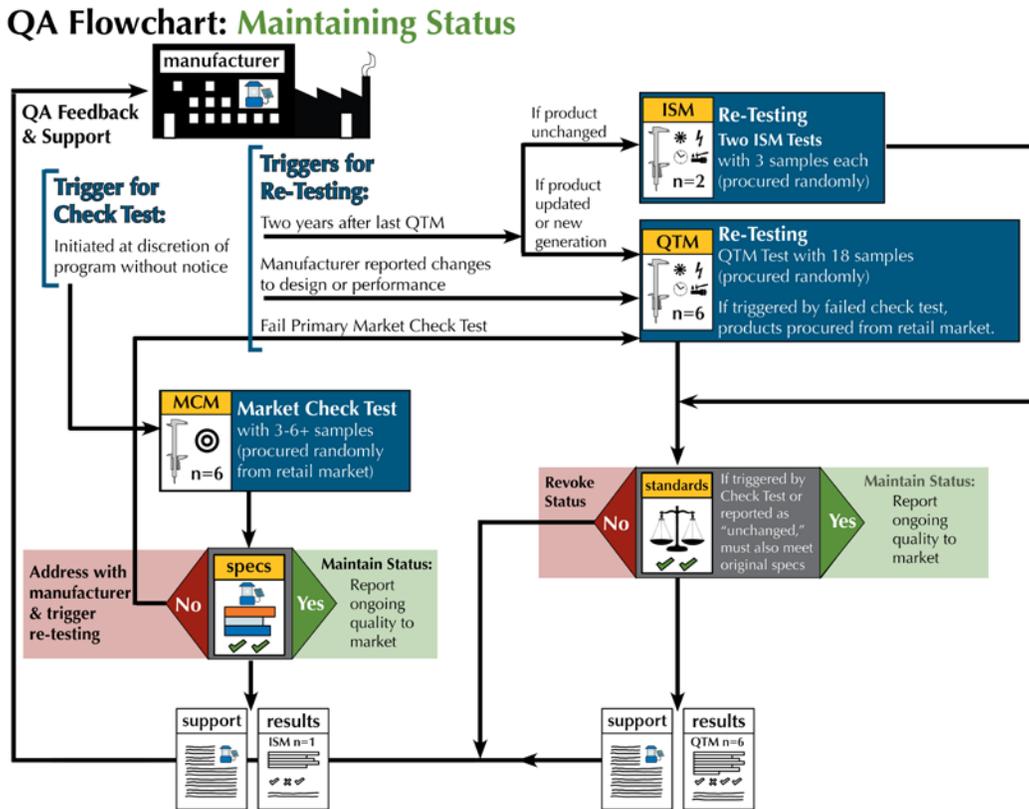

Figure 3. Process for maintaining product status, including Market Check Testing and re-testing due to expiration of results of pico-products. The same framework will apply for SHS products, though the number of samples required for Market Check Testing and Renewal testing will increase slightly due to the increased number of potentially destructive tests, and the full QTM testing would be conducted with 16 samples for a sample size of four.

Communication

The Standardized Specifications Sheet (SSS) is a key tool used to communicate the results of product testing. The SSS summarizes the Quality Test Method (QTM) or Accelerated Verification Method (AVM) results for a product in an easy-to-read format and allows comparisons between products from different manufacturers. Participating manufacturers can use the SSS to provide verified performance data to potential buyers. For distributors, bulk-purchasers, and retail vendors, the SSS offer a trusted resource for performance verification.

As part of the SSS implementation process, Lighting Global has conducted awareness campaigns and informed users and distributors about this means of quality verification.

Only products that have met the Lighting Global Quality Standards and have valid test results receive a SSS. In addition, products that have met the Quality Standards receive a Lighting Global Verification Letter that includes a type approval statement; this document can be used as proof that a product meets the Quality Standards. The SSS and Verification Letters are posted to the Lighting Global website, and users are encouraged to use the website to verify the authenticity of these documents. In addition to the Lighting Global website, the regional programs maintain websites with information about region-specific market interventions to overcome barriers within the off-grid lighting market (e.g., consumer awareness campaigns, workshops for microfinance and finance institutions, and market intelligence reports). Table 3 lists the methods that are used by Lighting Global and the regional programs to communicate with stakeholders.

Table 3. Summary of methods used by Lighting Global and regional programs to communicate with key stakeholders.

Stakeholder	Communications method
Consumers	Advertising campaigns and consumer education conducted by regional programs; SSS and website in cases where consumers have access
Manufacturers	Test reports, SSS, direct outreach by personnel associated with the Lighting Global and regional programs
Distributors, finance and microfinance, retailers, bulk purchasers, NGOs	SSS, website, direct outreach by personnel associated with the Lighting Global and regional programs
Governments (e.g., customs officials)	Verification Letters, SSS, website, direct outreach by personnel associated with the Lighting Global and regional programs

The Future of Global Quality Assurance

The Lighting Global QA framework is designed to balance stability with change. Stable test methods, processes, and thresholds for quality are important for maintaining clarity and relevance, both for those who offer products to the market and the buyers and institutions that need trusted information on quality and performance to drive investment and support decisions. However, as the market (quickly) grows and evolves, the Lighting Global QA framework continues to change as well. The process for updating the framework is based on stakeholder feedback, new information from end-users and supply chain actors, and careful analysis of technology trends in the context of our growing database of test results.

In on-going assessments, Lighting Global has identified several key challenges associated with adapting and scaling the Lighting Global QA program during the coming years as the program continues to transition from a small scale effort that matches the needs of the early market to a larger program that involves increased testing volumes and engagement with greater numbers of people and institutions who rely on timely and trusted information from the program. To date, some measures have been taken to address key challenges that were identified, while other measures are under development.

<u>Challenge 1:</u> <u>Create a **faster, lower cost process for product testing** without diluting the strength and value of the quality assessment.</u>

Two guiding principles of the Lighting Global QA program are *rigor* and *affordability*. The Lighting Global test methods are designed to incorporate low-cost, yet reliable procedures to seek a balance between these two opposing principles. Despite these considerations, manufacturers continue to rightly cite the duration, expense, and sampling requirements of testing as barriers to successful market entry for new products. Future revisions of the test methods, the expansion of the test lab network, and upcoming changes to the QA framework are all measures currently in progress that are intended to address these concerns.

Drivers:

- **Testing takes too long**: Manufacturers bring products to the market at a fast pace, often with model life cycles of one or two years. The 3-4 month time period for testing can create a barrier for effective distribution of new products, since it can represent 25-50% of the product life cycle. Speeding the time from testing initiation to completion of an assessment, while maintaining the rigor of the program, will better serve both sellers and buyers who want to access the best quality products for their needs that are currently available.

- **Testing is too expensive:** Many companies working in the off-grid lighting market do not have access to substantial capital. Testing fees and associated shipping costs, which are commonly in excess of US$7,000 per product, can be a significant barrier to bringing products to the market. Lowered testing costs enable emergent businesses to access program resources and may result in lower cost products for consumers. Note that the overall cost of testing has not changed significantly over the past several years, but the level of subsidy provided by IFC and World Bank – initially a large fraction of the cost of testing, has slowly been phased out. As a result, in the case of pico-solar products, manufacturers have been paying the full cost of testing for the past few years.

- **Requiring 500 products to be available for sampling is burdensome:** To ensure a random sample of products for QTM testing, Lighting Global requires that the 18 products sent for testing be selected from a warehouse with at least 500 units of the same model for pico-products and that 16 products be selected from an available stock of 200 units for SHS kits. Smaller manufacturers or those with alternative manufacturing methods, such as "just-in-time" production, do not typically produce or store 500 units at a time, making this sampling requirement expensive and disruptive to meet. Moreover, even manufacturers with large volume production typically produce in batches, and they generally seek to move the product offsite as soon as possible in order to fulfill orders. If the timing of sample collection is not coordinated precisely, this can hold up orders or lead to delays in the timing of sample collection.

Recent Activities and Next Steps:

- **Development of the Accelerated Verification Method (AVM) [initial framework in place]:** As described above, the AVM is an optional, alternative quality verification pathway to the QTM that is designed to reduce the testing time from about four months to approximately eight to ten weeks. Eligibility is based on the manufacturer's strong history of success with the Lighting Global QA program, and compliance is monitored through a mandatory follow-up QTM test. Initial experiences with the AVM indicate that it does reduce the time to get a quality-verified product to the market, but

the heightened costs and additional risks and responsibilities do not make the pathway appealing to all eligible companies. Additionally, because full QTM testing with randomly-sampled products is still required after the initial verification period, the burden of preparing the required stock quantities (500 or 200) still exists. Other companies and organizations have expressed that by requiring specific eligibility criteria, the AVM is providing significant advantages for existing market leaders, which could stifle new entrants. In coming months, we intend to revisit and revise the AVM method in consideration of this feedback.

- **Enable qualification of 'families' of products [complete]:** Some manufacturers offer product lines that consist of a series of similar product models that involve a common set of components. Lighting Global has developed a policy for evaluating these families of products through custom test plans that are designed to minimize the cost to manufacturers while still carrying out a rigorous evaluation of the product line. This approach allows manufacturers to have an entire line of products verified through a single custom test plan, thereby saving time and money.

- **Revisit and revise the test methods [ongoing]:** The Lighting Global test methods as institutionalized in IEC TS 62257-9-5 are dynamic and meant to be revised regularly based on stakeholder input and market needs. The Lighting Global QA team has identified and incorporated a number of changes to the test methods over the past several years, including several measures aimed at reducing the amount of time required to complete testing. Two recent examples are the development of a shorter lumen maintenance pathway based on LM80 data and removing the requirement for measuring light distribution. The proposed application of the ports and protection tests for all products with ports could slightly increase the cost of testing, but is expected to have little impact on the overall duration of testing. A revised version of IEC TS 62257-9-5 is currently under review in the IEC process.

- **Develop additional testing capacity closer to manufacturers [ongoing]:** The majority of products are produced in China and most sampling occurs at warehouse and factory locations in China. To facilitate lower cost testing and minimize sample shipping costs for manufacturers, Lighting Global has expanding the test lab network to include labs located in China, closer to manufacturing centers. Lighting Global added a lab in China (SMQ) to the test lab network in late 2014. SMQ is capable of carrying out QTM testing, and we are working to add more labs in this region. We recently signed cooperation agreements with Intertek Hong Kong and TUV SUD. We expect Intertek HK to begin providing testing services this year, and TUV SUD is likely to be ready to conduct tests in the first half of 2017. Lighting Global has also worked to develop test lab capacity in India through engagement with a test laboratory at TERI University, as production for some manufacturers is located there.

- **Develop a stronger "watchdog" in the market [ongoing]:** During its initial years, the QA program acted as more of a "gatekeeper" to ensure that only quality-verified products were supported by IFC programs. However, with market growth and the introduction of a wider range of test labs, market surveillance activities, in which products already on the market are monitored for quality, became increasingly important. Lighting Global created a Market Check Method testing framework, and we have been working to increase the frequency of market check testing to ensure adequate monitoring of the market. Lighting Global is also exploring new avenues to develop a sustainable financing mechanism to ensure financial support for these watchdog efforts, such as a market check test fee that would accompany Accelerated Verification Method and PAYG testing.

Challenge 2: Increase the scope of the Quality Assurance framework to measure system types and features that are prioritized by the market.

The initial focus for Lighting Africa and Lighting Asia activities in the off-grid lighting market was lighting. This was reflected in how the program described products ("modern off-grid lighting products") and programs ("Lighting" Africa, etc.). As the market has matured (and LED technology along with other superefficient appliances continue to improve), pico-power energy systems now do much more than just provide light. Mobile phone charging, low-power televisions, fans, radios, and other appliances can now be powered by pico-power kits, with the available service depending on the system size. Moreover, plug-and-play solar home system (SHS) kits that are somewhat larger than those typically considered to be 'pico-power' systems have become increasingly affordable. In response to these continued trends, the QA framework has expanded to cover new energy technology areas.

Drivers:

- **Larger kit-based systems with solar module wattages greater than 10 watts are becoming more common and affordable:** Historically the scope of the QA program has covered products with solar modules ranging from 0 to 10 watts. The decreasing cost of solar PV modules, rechargeable batteries, and LEDs have facilitated the development of larger "plug-and-play" SHS kits at a price affordable to many in the off-grid lighting market. These have larger solar modules, often ranging between 10 and 100 watts or more, and offer a wide range of services. The test methods included in IEC TS 62257-9-5 (i.e. the methods used by Lighting Global to evaluate pico-solar products) were not appropriate for effectively testing many aspects of these larger kits.

- **Products of all sizes offer auxiliary services:** Based on consumer demand and because more and more energy is available (since LEDs require less and less power), many products provide power for auxiliary loads, the most common of which is mobile phone charging. The test methods included in IEC TS 62257-9-5 do not thoroughly assess these auxiliary uses, and measurements of full-battery and solar run times do not account for the impact of also using the product to charge a mobile phone or power other devices.

- **Pay-as-you-go or fee-for-service products are rapidly increasing in the market**: Beyond additional energy services, some products now include onboard metering and billing technology ("pay-as-you-go" systems). The accuracy of metering and quality of these systems is an important element of the end-user experience. The metering and payment enforcement elements of these systems also present difficulties for testing, especially when the product is tested outside of its intended market or away from a compatible mobile phone network.

Recent Activities and Next Steps:

- **Extend scope of product testing to cover larger DC SHS kits [ongoing]:** Lighting Global has developed test methods and standards for plug-and-play DC solar home system kits. To date, the methods have been used to evaluate 11 SHS kit products, 8 of which met the Lighting Global Quality Standards for SHS kits and are listed on the Lighting Global website. In addition to the eight listings, the SHS kit testing enabled three "families of products" to also be quality verified. These product families include over 30 variations of SHS kits. It is anticipated that these methods will be incorporated into an

upcoming revision of IEC TS 62257-9-5. Once complete, this will result in a unified framework for preconfigured solar products and kits ranging from 0 to 240 W.

- **Build test lab capacity for testing larger SHS kits [ongoing]:** In parallel with developing new test standards, the test labs that will measure system quality and performance need to be identified and prepared. We plan to both expand the network of test labs to include labs that already have capabilities in this area and build the capacity of labs that thus far have focused on pico-power lighting systems.

- **Measure and report auxiliary power capabilities for pico-power products [ongoing]:** The work we complete in support of SHS testing has resulted in better methods for estimating the level of service available to users who plug their own appliances (like mobile phones) into the full range of pico-power systems. These methods will likely be incorporated in an upcoming version of IEC TS 62257-9-5. A key on-going challenge to this effort is establishing an effective and clear way of communicating the capabilities in light of the wide diversity of power consumption for mobile devices and the impact of user behavior on performance.

- **Provide quality verification for pay-as-yo-go (PAYG) systems [ongoing]:** We are incorporating a test method into IEC TS 62257-9-5 that offers targeted testing of fee-for-service or PAYG-enabled versions of products that previously qualified for market entry or market support programs through the process of QTM or AVM testing. This targeted testing will only test aspects that are different from the non-PAYG version of the product and will not require randomly selected samples. Instead, the QA program will rely more heavily on Market Check Testing to confirm product performance. We are additionally expanding the questions we ask of manufacturers prior to testing to better understand and address any difficulties that may arise during testing due to complications with the PAYG payment system.

Challenge 3: Improve communication to buyers

Our program's initial efforts with regard to communication of information about product quality have focused primarily on reaching upstream supply chain actors (e.g. product importers and distributors), bulk purchase buyers, financial institutions, investors, and government officials. We chose this approach in part because of the important role that these actors play in the market and in part because it is relatively easier and less costly to reach these people and organizations than it is to reach retail vendors and end consumers. While this approach has contributed to the success of the Lighting Global Quality Assurance program, the effectiveness of the program can be enhanced through selected, cost-effective measures aimed at making information about product quality more widely available to "downstream" actors such as retail vendors and end consumers.

Drivers:

- **On-the-package information about product performance is not reported uniformly**: Buyers of off-grid lighting products are best positioned to make good purchasing decisions when they have access to accurate and reliable information about product quality and performance. The Lighting Global Quality Standards help ensure that qualifying products meet basic minimum quality requirements and that manufacturers adhere to truth-in-advertising. However, it is additionally important for end-consumers to be able to compare products with regard to key performance metrics when they are

considering a purchase. On-the-package reporting requirements that ensure that all products that meet the Lighting Global Quality Standards report key metrics in a consistent way can help achieve this goal.

- **The Lighting Global website remains inaccessible for most retail vendors and end-users**: The Lighting Global website is the program's primary tool for communicating information about product quality to supply chain buyers and other key stakeholders. However, important stakeholders, such as retail vendors and end consumers, do not have reliable access to this information due to lack of conventional internet connectivity. Lighting Global research indicates that an increasing number of retail vendors and end consumers are accessing the internet through mobile devices such as smart phones and feature phones. Designing website content that is compatible with these mobile devices can therefore help expand our program's ability to reach these important stakeholders.

- **Program lacks "on-the-package" quality seal:** While many manufacturers, distributors and standards/customs agencies understand the value of the Lighting Global SSS and Verification Letter, the program currently lacks an "on-the-package" mechanism to effectively communicate quality-verified status and/or performance to buyers across the supply chain. While country programs associated with Lighting Africa and Lighting Asia have used (or are planning to use) consumer awareness campaigns to communicate quality in some countries and regions, this approach is limited geographically and is unlikely to continue after current program funding expires. A quality seal or label, if deployed effectively and with sufficient resources, could help buyers across the supply chain and manufacturers of high quality products alike by clearly signaling product quality to the market. An effective quality seal could also help generate demand for a long-term quality assurance program, provided that it delivers value to manufacturers of good quality products at a reasonable cost.

Recent Activities and Next Steps:

- **Implemetation of on-the-package reporting requirements [complete]**: In 2015, Lighting Global implemented a policy on performance reporting that requires manufacturers of quality-verified products to display key performance information on their packaging. The reporting requirements include the metrics that consumers have indicated are the most important to them, such as product light output, run time, and warranty terms. The requirements for SHS kits have not fully been established, but currently include presenting the PV module power rating of the kit on the box. While manufacturers are required to report particular metrics, they have flexibility with regard to the format for presenting the information. The policy was developed in close collaboration with the Global Off-Grid Lighting Association and is available on the Lighting Global website.

- **Development of online information about product quality assurance that is accessible through mobile devices [ongoing]**: Lighting Global is in the process of improving web content related to product quality assurance to make it more compatible with mobile devices such as smart phones and feature phones. We expect to make this content available over the coming year. The goal is to enhance our progam's ability to deliver information about product quality to key stakeholders who access the internet primarily through mobile devices.

- **Analysis related to the development of an "on-the-package" quality seal [ongoing]:** Lighting Global, Lighting Africa, and the U.S. Department of Energy conducted a preliminary analysis of communication strategies to effectively deliver information about quality to buyers across the supply

chain. The analysis was led by Navigant Consulting in close collaboration with the Lighting Global QA team. This analysis indicated that a basic "business to business" (B2B) quality seal has potential to be an effective tool for delivering information about quality at a reasonable cost. A consumer-facing quality label might also be considered, but the marketing costs required to effectively raise awareness about the label are substantial. Moreover, prior experience with quality labels indicates that they are most effective when the branding and communication materials are tailored to a particular country or region (i.e. a uniform, global quality label may not be a viable and effective strategy). Lighting Global is committed to improving its ability to communicate quality across the supply chain. Analysis of this topic is ongoing, and a decision about next steps has not yet been finalized. Given that effective implementation of a quality seal is a substantial task, it is unlikely that Lighting Global will initiate this task before transitioning to the new management structure for the quality assurance program.

Challenge 4: Government adoption of the QA framework

When the QA program was first conceived, the primary purpose was to distinguish which products should be eligible for support through the Lighting Africa market development programs. Now, however, the framework is being adopted by a number of countries and national programs, and it is also utilized by many key development organizations in addition to the International Finance Corporation and World Bank, such as GIZ, SNV, and the UNFCCC Clean Development Mechanism. As increasing numbers of governments and organizations adopt standards for off-grid lanterns and solar home system kits, the need for harmonization of standards becomes more critical. Lighting Global is working with government standards bureaus to ensure that government standards are harmonized with the existing Lighting Global QA framework. Harmonized QA means:

- ✓ QA programs utilize single set of (IEC) test methods and standards
- ✓ Companies test their products at a qualified lab and then can enter multiple markets

Harmonization benefits companies, governments, and end-users by keeping costs low and allowing innovative products quick market entry.

Drivers:

- **An increasing number of governments and organizations are adopting standards for off-grid lanterns and solar home system kits.** While protecting markets, programs and consumers by instituting standards for off-grid products is commendable, as each new government and organization adopts standards, the risk of inconsistent and conflicting requirements increases.

- **An effective, globally harmonized quality assurance system would help enable access to reliable and affordable lighting and energy services for people living in off-grid areas of Africa, Asia, and beyond.** A key next step in the development of an internationally harmonized quality assurance program is widespread adoption of a common quality assurance framework. Harmonization brings value to off-grid lighting manufacturers and buyers, as well as to governments in countries where the products are used. Manufacturers benefit because products that meet the requirements only need to be tested once in order to qualify for a number of markets, thereby simplifying the process and reducing costs. The savings from the simplified qualification process helps reduce the cost of delivering off-grid lights to market, thereby benefitting buyers. Governments that adopt the framework can effectively act to protect consumer interests in their countries with relatively modest effort and investment.

Recent Activities and Next Steps:

- **Engaging with government standards organizations [ongoing]**: Lighting Global is working with Lighting Africa and Lighting Asia program staff to engage with governments to assist the adoption of harmonized test methods and quality standards. Lighting Global recommends adoption of both the IEC TS 62257-9-5 test methods and the Lighting Global Quality Standards in order to achieve an internationally harmonized quality assurance framework for off-grid solar products. The key goals emphasized during government engagement are to encourage governments to adopt the internationally harmonized QA approach, accept product test results from any qualified laboratory internationally that carries ISO 17025 accreditation to test to IEC 62257-9-5 as evidence with regard to meeting the quality standards, and to adopt measures to prevent sales of counterfeit products.

- **Providing advice regarding the creation of national test labs [ongoing]:** Though product testing can be completed through an existing international network of test laboratories, some countries are interested in establishing in-country test labs capable of conducting the IEC TS 62257-9-5 testing. In select cases, Lighting Global has assisted with the development of in-country test labs through recommending equipment and providing technician training. In-country test labs are not necessary to establish in every country, but regional test labs in active off-grid solar markets serve a key function of conducting market check tests and other market surveillance tasks.

- **Encourage development organizations and bulk purchasers to reference the Lighting Global QA framework and the list of quality-verified products [ongoing]**: Lighting Global has reached out and developed resources to assist organizations in ensuring they are sourcing quality off-grid lighting products by procuring Lighting Global quality-verified products. Bulk purchasers and development organizations are encouraged to utilize the Lighting Global Quality Standards as a screening tool when selecting products for inclusion in their sales portfolios and programs, respectively. Development organizations can also apply to receive notifications when products are removed from the website to assist with their program management.

Challenge 5: Long-term sustainability of QA program

The existing Lighting Global program, including the quality assurance component, is scheduled to end in June of 2017. While the program is likely to be extended beyond this date, it cannot continue indefinitely. The need for quality assurance in the off-grid lighting and energy systems market will continue into the future, and it is therefore important to establish a financially viable, long-term framework that will allow for continuation of the quality assurance effort.

Drivers:

- **Long-term sustainability of the QA program:** The QA program has been supported by the IFC and World Bank through the Lighting Global, Lighting Africa, and Lighting Asia programs, and it will continue to be supported by the IFC and World Bank in the context of the Lighting Global program in the near future. Other organizations such as the U.S. Department of Energy and GIZ have also provided funding for specific quality assurance related activities. However, the market need for trusted and reliable information about product quality will continue well beyond current commitments from these institutions. Over the coming year, Lighting Global must therefore determine a strategy and business model that will help ensure that effective quality assurance services are maintained on a sustainable basis beyond the end of the program.

Recent Activities and Next Steps:

- **Development of a long term quality assurance strategy [ongoing]:** Lighting Global has been working to develop a long term strategy to institutionalize the quality assurance effort so that it can be sustained after current program support from IFC and World Bank ends in about two years. This effort has involved support and collaboration with partners such as the U.S. Department of Energy, Lawrence Berkeley National Laboratory, Navigant Consulting, and the International Electrotechnical Commission. It has also involved engagement with key industry stakeholders such as the Global Off-Grid Lighting Association (GOGLA).

  - One of our strategic partners, Global LEAP, has support efforts to develop a long term quality assurance strategy for the off-grid solar sector by funding a study carried out by Navigant Consulting titled, "*Analysis of the Potential Future of the Lighting Global Quality Assurance Program.*" The work involved close coordination between Lighting Global, Navigant Consulting, and the Global Off-Grid Lighting Association (GOGLA).

  - Analysis to date indicates a need to establish a trusted, reliable, and independent certification body that builds on the experience of the existing Lighting Global program. Through a rigorous application process, CLASP, an international NGO based in Washington, D.C., was selected to lead the quality assurance program in the coming years. The organization has extensive experience with standards and labelling for energy efficient appliances. Moreover, it has experience supporting the development of markets for off-grid appliances through programs such as the Global LEAP Off-grid Appliance Awards. The next years will serve as a transition period for the Lighting Global Quality Assurance Program. During this period, CLASP will begin to take a leadership role in management of the program, in collaboration with the existing Lighting Global team, the Global Off-Grid Lighting Association (GOGLA), and other partner organizations.

  - Key steps that represent progress toward laying the foundation for a long term quality assurance framework have already been taken. These include:

    - Institutionalization of the quality assurance framework through the IEC in the form of IEC TS 62257-9-5.

    - Expanding and commercializing the testing framework, thereby increasing the options for manufacturers that seek testing services for their products.

    - Working to establish a strong working relationship with GOGLA in order to enable GOGLA to serve as a key conduit for industry input on matters related to quality assurance.

- Additional important steps will be taken over the coming months and years.

Conclusion

Lighting Global is committed to the continued development of a practical, dependable, and sustainable quality assurance framework for off-grid lighting and energy systems. This document briefly describes the existing quality assurance program and identifies areas for future change as the program works to adapt to evolving

market conditions. In some cases the measures described in this document will take time to develop and implement, but with patience and persistence we are confident that we can succeed. We value input from key stakeholders ranging from product manufacturers to end-users, and we look forward to continued engagement as we work to fulfill our mission of quality-assured clean energy systems for off-grid applications.